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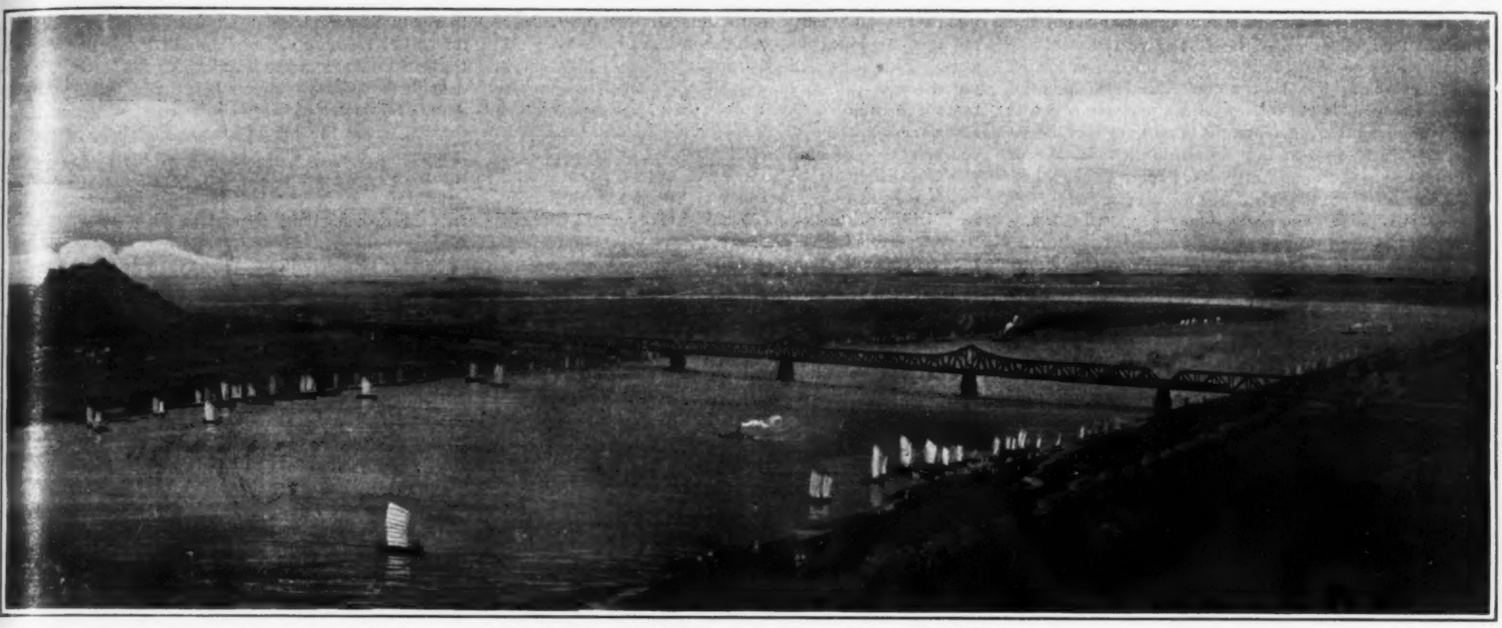
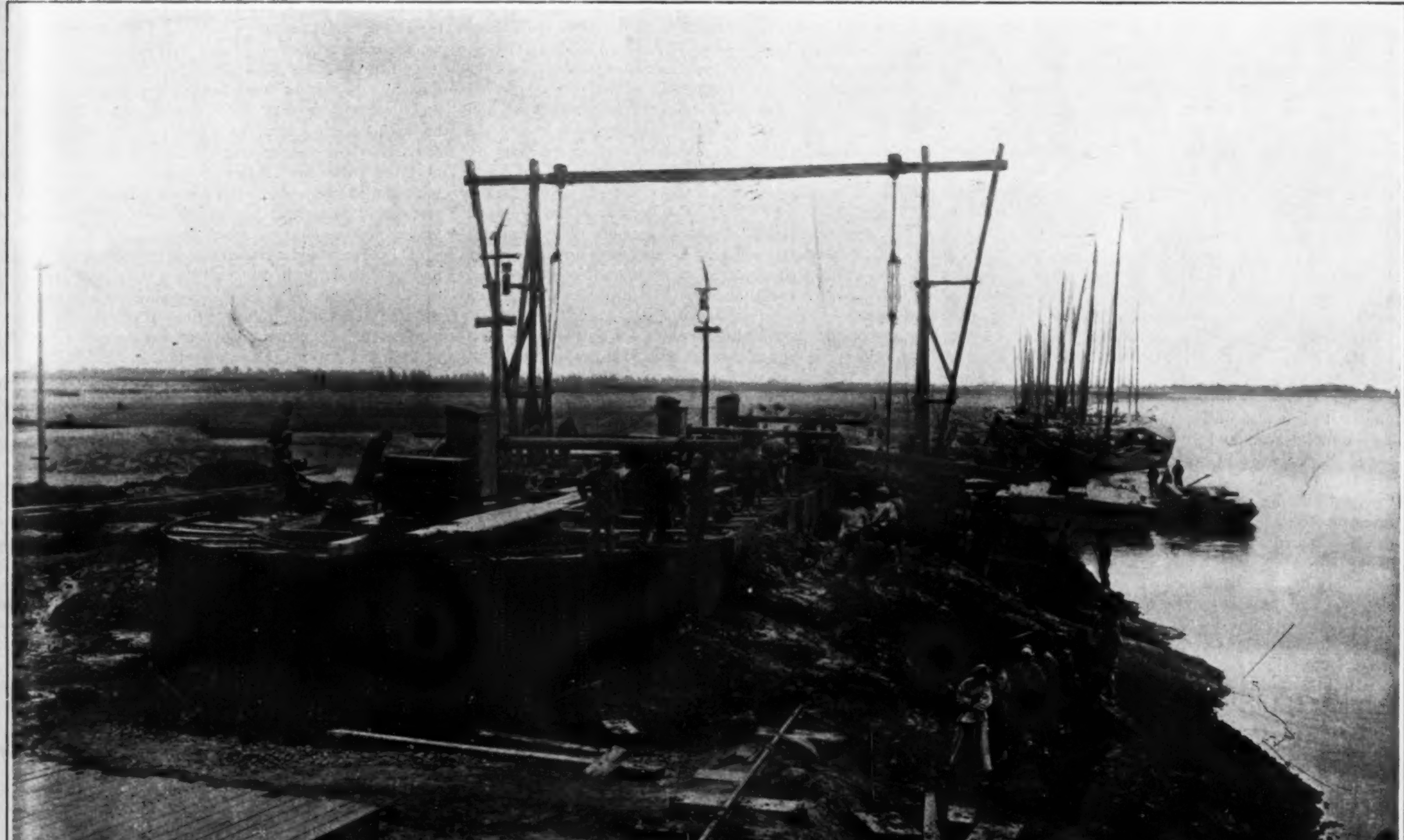


The New Railway Bridge Across the Hwang Ho, China.



Building Site of one of the Land Piers, Showing Caisson.

A CHINESE RAILWAY BRIDGE.—[See page 181.]

Preliminary Report to the Inventors' Guild—III*

The Guild's Relation to Patent Practise

By F. L. O. Wadsworth

Concluded from Scientific American Supplement No. 1941, page 166, March 15, 1913

(7) There is the most pressing need for greatly expediting and accelerating the progress of a patent suit through our courts so as to obtain a speedy, final and conclusive adjudication of the respective rights of the patentee and of the public: Under the present rules of Federal Court procedure, and the loose practice based thereon, it is possible for either party to a patent suit, complainant or defendant, to prolong the litigation for years, and to impose an intolerable burden of expense on the opposing party. All this should be changed, must be changed, before we can ever hope to reap the advantages which are supposed to flow from the granting of patent protection to meritorious inventors. The issue of a patent confers upon its recipient or its owner no vested rights save merely the right to sue those who seek to use his invention without consideration. Until a patent has been adjudicated it is of no value to its owner, he can not even be sure that the possession of it is of the slightest value. There is, therefore, the most crying need for such a reform in our Federal Court procedure as will enable anyone, the user as well as the owner, to determine with a minimum loss of time and at a minimum of expense, just what rights a patent confers upon its possessor, to determine the metes and bonds of the preserve upon which no one may encroach without paying tribute to the owner thereof.

This being admitted, the question is what steps can be taken, what changes instituted in our present practice, to facilitate the speedy determination of the questions involved in patent suits.[4] Perhaps the most promising reform would be to have the trial of the case conducted in open court, and where once begun, carried on without adjournment until concluded by the final arguments before the presiding circuit or district judge. Such a procedure would probably be impracticable unless the number of our district judges was increased or the complete plan of a Patent Court adopted. The present practice of taking the testimony before examiners who certify the record to the court has many advantages, and saves the time of the court, but this very practice is the one that opens the door to interminable abuses and delays in making up the record for final hearing. If, therefore, that practice is to be continued it should be subject to rigid restrictions as to the time allowed to each party to close its proofs and as to the places at which testimony can be taken. As an example of such restrictions the complainant might for example be compelled to complete its *prima facie* or opening proofs within fifteen to thirty days after the filing of defendant's answer, or have the suit dismissed; defendant might be compelled to complete his record within one or two months after the closing of complainant's *prima facie* case; and complainant might then be allowed thirty days in which to complete his rebuttal proofs. The complete record might then be made up for final hearing within three to four months after the filing of the answer to the bill of complaint. The right of extending this time by stipulation between the parties should be absolutely abolished, and an extension of time only granted by the court on the most convincing showing that such extension was absolutely necessary. Both our courts and the parties to the suit seem to completely forget or ignore the fact that the *public* has a most important and vital interest in the outcome of patent litigation, and that the public rights are to be considered and protected quite as much as the rights of either patentees and patent owners, and of alleged infringers of patent rights. In this connection I think it would be desirable to have a statutory provision making it mandatory upon the court to decide as to the validity or invalidity of any claims that might be in issue. Now the courts will sidestep the decision of that question whenever it is possible for them to base their findings on any other grounds.

In the case of appeals from the decisions in the Circuit Court, to the Court of Patent Appeals, it should be provided that all such appeals should be set down for argument within three months after the date of filing of the appeal, and no extensions or postponements granted except under the most extraordinary circumstances.

Under the plan of procedure, above outlined it would be possible to obtain a final adjudication of a patent suit within one year after the filing of the bill of complaint, the same rules as to time allowed for filing of answers, appeals, etc., being continued.[5]

(8) The reduction of the expense of litigation in patent suits is also of considerable importance. The establishment of a Court of Patent Appeals (to which all cases would be appealed directly from the circuit courts); the appointment of experts by the court, and the expediting of the conduct of the litigation, would all co-operate to reduce the expense of such litigation. But there are further provisions which should be made to reduce this. If either party insists on taking testimony at a point more than one hundred miles outside the district in which the suit is brought that party should be compelled to pay the traveling expenses of opposing counsel in attending the taking of that testimony. Any question as to the reasonableness of such charges shall be referred to and settled by the clerk of the U. S. Circuit Court for that district. Another matter which demands immediate attention is the readjustment and very substantial reduction of the fees allowed to examiners for taking testimony. Under the present practice the examiner is authorized to charge 20 cents per folio for the original and 10 cents per folio for each copy of the testimony and he is further authorized to make a fixed charge of $3.00 per day for his services, and an added charge of 25 cents for each witness sworn and each exhibit introduced. At these rates the examiner's legal charges frequently amount to as much as $30 to $40 per day. All that he has to do is merely to take down the testimony either stenographically or directly on a machine, swear the witnesses, mark exhibits and certify the record to the court. No ability is required save that possessed by any good stenographer. Frequently in fact the examiner merely hires another stenographer, or more frequently still, the stenographer in one of the attorney's offices does the work; and he himself does not do anything except to swear the witnesses and mark the exhibits, duties that occupy perhaps ten minutes of his time per day. Yet he is allowed for such service nearly as much as is charged by the best expert witnesses or by counsel in the case. The present charges are nothing more than legalized graft. The statutes should be changed so as to merely allow a fair charge for good stenographic service and for ordinary notarial fees—20 per cent of the present allowance would be ample for this.

Provisions should also be made for reducing the cost of taking an appeal by eliminating the necessity of reprinting and certifying the complete record of the case in the lower court to the Court of Appeals. This can be easily done either by adopting the method of appeal by case and exceptions, and having the record made by counsel and settled before the judge who heard the case, or by the acceptance by the Court of Appeals of duplicate copies of the record printed for the lower court.

(9) Under the present practice and procedure in patent causes the only direct benefit which accrues to the complainant at the termination of the suit in his favor is the issuances of an injunction against further infringement by the defendant. This is of little benefit to the owner of the patent unless he is himself manufacturing under the patent. The defendant may have derived great benefit from his unlawful use of the patent or he may perhaps have nearly ruined complainant's business by competition. Yet all that the decision does is to prevent the defendant from *further* infringement, and it leaves the complainant only the very doubtful chance of recovering profits and damages, for defendant's *past* unlawful acts, by instituting an accounting suit. Some more definite and immediate recovery by complainant of a part at least of the expenses of litigation should be provided for. One way of doing this would be to provide that immediately upon the final finding for complainant, defendant shall be required to pay not only the usual court costs, but also to repay to complainant his cost for counsel fees and for expert testimony, and it might be further provided that it shall be mandatory upon the court to order defendant to pay to complainant a fixed sum, say $1,000, for each and every six months or fraction thereof elapsing since the bill of complaint, charging infringement, was filed. This payment should not constitute in any way a partial payment of profits and damages recoverable on accounting but should be entirely separate and independent of, and in addition to, any such recovery.

(10) There should be the same provisions made for expediting the progress of an accounting suit for profits and damages, as have been already suggested for expediting the final adjudication of the patent cause in chief. But more than this there should be a more general recognition by the courts of the rights of a patent owner to the recovery of profits or substantial damages for the infringement of his patent rights. The rules and principles of equity rather than the technicalities of law should prevail in this adjudication of the questions arising in accounting proceedings. This is especially true because of the fact that an infringer is under no compulsion or necessity for appropriating the patented ideas of another. If he chooses to do so, after notice to him of such infringement, he presumably does so with his eyes open to the consequences. If he persists in his unlawful acts he should be made to pay, and pay heavily for the wilful injury he does the complainant, no matter whether such injury may or may not be susceptible of the most strict and technical legal proof. There have been in the past some most woeful miscarriages of justice in accounting suits, and it is little wonder that a successful complainant frequently chooses to abandon all his claims to profits and damages, no matter how good those claims may be, rather than submit to the endless delays, the vexatious postponements, and the heavy expenses which he must encounter in the prosecution of these claims, with the chances about ten to one against him of ever recovering enough at the end to even pay the cost to him of the accounting suit.[6]

(11) The standardization of laws relating to patents and patent rights in the various countries of the world is the first requisite to the satisfactory international conduct of business founded upon or affected by patent protection. At present the variance between the laws of different nations is so great that it is almost impossible for the inventors or manufacturers of one country to undertake or carry on a patent development enterprise in any country but their own. Conditions are not quite as bad as they were before the ratification of the articles of agreement entered into by the International Convention for the Protection of Industrial Property in 1900, which took effect in the United States in September, 1902, but they are still exceedingly unsatisfactory. All countries recognize this and at the coming meeting of the International Congress, to be held in May, 1911,[7] at Washington, we may expect to see some further effective action taken which will remedy in part the present evils. It behooves the inventors and business men of this country to formulate and crystalize their views as to the legislation needed to effect the reforms desired in this matter, before this next meeting of the International Convention, and see to it that the patent interests of this country are typically, effectively, and ably represented at the coming (1911) session of the Congress.

(12) One of the greatest hardships on American inventors who take out patents in foreign countries, is the imposition upon them of the requirement to "work" their invention in the foreign country within a limited period or forfeit their rights to protection. There is no sense or justice in such a requirement. An invention is the property of him who makes it; he can give it to the public, or withhold it as he sees fit. The public would not suffer if an inventor did not choose to publish or proclaim what he has discovered, for the simple reason that they would then know nothing about it; they would be exactly as well off as they were before he made his invention. The fundamental theory of the patent law is that an inventor or dis-

* Chairman of the Professional Committee of the Inventors' Guild.

[4] In this connection see report of the Special Committee on Federal Procedure to the American Bar Association, Chattanooga meeting, August, 1910.

[5] The new equity rules promulgated last November by the U. S. Supreme Court, which went into effect Feb. 1st, 1913, contain provisions which are intended to encourage the trial of causes in open court and to expedite the progress of the suits to final hearing. It is to be sincerely hoped that these rules will not fail of their object, but only the test of time and experience will determine the efficacy of their provisions. Personally, I do not see how the district courts can find time to try all patent cases in open court, nor can I see how such trial, under the conditions now existing, can reduce the expenses of litigation. The consensus of opinion seems to be that such expenses will be increased, under the new rules, rather than diminished. But there is no doubt but what a sincere effort is being made by the judiciary to improve present conditions and facilitate the administration of justice.

[6] There has been a very marked and very commendable change of attitude in this matter recently.

[7] This report was presented to the Guild at its November meeting, 1910, but is here published for the first time.

coverer shall be awarded a limited exclusive right to the use of his invention, for the purpose of inducing him to disclose the fruits of his labors to the public instead of keeping them to himself; so that after the expiration of that limited right the public may benefit by such publication. But during the continuance of the inventor's grant of exclusive protection, he is, or ought to be, his own master. There is no reason or logic in compelling him to manufacture under his rights or forfeit them. Such a provision is contrary to the whole spirit of the grant. It is as unfair and unreasonable as it would be to give a man a prize or a reward for some conspicuous public service and then fine him two or three years later for not turning over what he had received to some public institution.

(13) The provisions of the patent law, as relates to issued patents of the United States, are in many respects the most liberal in the world. Foreigners taking out patents in this country enjoy all the advantages of these provisions equally with American citizens. There is no "working clause" in our patent laws, no forfeiture provisions, no annual taxes, no penalties or fines of any kind for non-manufacture. A foreign patentee can do what he pleases with his American patents, or do nothing at all with them, secure in the conviction that the courts of this country will protect him at all times during the life of his patent against infringement or unlawful use by others. An American inventor has no such guarantee; instead of foreign governments co-operating in securing to him the rights which they are supposed to have granted to him as a reward for disclosing his ideas, they actually seek to take away from him, by unreasonable and unjust requirements, the very prize which they have offered as an inducement to give to them the benefits of his labors. The half-hearted and wholly illogical argument that an inventor does not need to take out foreign patents unless he wants to is so ridiculous as to refute itself; for the simple reason that the publication of his United States patent is a disclosure to all the world of his invention. The spirit of fair play alone demands that American inventors be granted the same protection and the same privileges in foreign countries as citizens of those countries enjoy in the United States; or failing this that this Government discriminate against patentees of foreign countries to the same extent as the governments of those countries impose penalties and forfeitures on American patentees. Reciprocity, however, and not retaliation, should be the guiding spirit in international relations.

(14) In view of our present tendencies toward the principles of universal free and unrestricted trade among nations, there is almost the same necessity for the international recognition of the principles of comity, between the patent courts of different countries, as there is for such recognition by the various Appellate Courts of Jurisdiction of our own country (see supra, 5). This is particularly true in view of the fact that an inventor holding only a patent on a process or a machine and not on an article has no protection against the sale of the product of his process or machine, when that product is produced outside of the United States, save such protection (?) as he may have in foreign patents covering his process and machine. If the owner of such method or machine patents has successfully established his rights to their exclusive use in this country, foreign courts ought to take judicial cognizance of such facts and enjoin citizens of their own country from manufacturing such products by the same patented processes or machines, or at the very least ought to enjoin the sale of such products by their citizens in the United States.

Reciprocally the courts of this country should enjoin American citizens from infringing patent rights which have been recognized and established by Equity Courts of foreign countries. Such injunctions would not of course be permanent but would restrain infringement of the adjudicated rights until the questions at issue could be again passed upon by the home courts of the parties to the controversy.

. . . .

In concluding this brief review I desire to emphasize again the introductory statement that the various suggestions that are made in reference to possible changes and reforms in our present patent office practice and Federal Court procedure, are not to be considered in any sense as definite and final recommendations to this Society. I cannot emphasize too strongly the danger of hastily indorsing and attempting to inaugurate plans of improvement that have not been very thoroughly and critically considered from every possible point and angle of view. On the other hand everyone who has devoted any serious thought to our present system of patent law practice and procedure is convinced that it must be changed and in some respects reformed.

There is a medium line of moderation, intermediate the experimental and possibly dangerous innovations which are urged by the radicals, and the stand pat *laissez faire* doctrines of the unduly conservative; and it is to this line that the Society should hew its way. To lay down that line carefully, yet not too conservatively, deliberately, yet without undue delay, is the first and most important task, and it is one that will demand the best thought and most earnest and impartial effort of every member of the professional committee and of the Society. In reaching our conclusions we need the suggestions and the criticism, and the active assistance in our deliberations, of all those who have given attention to the subject we are considering, be they inventors, manufacturers, engineers, members of the bar, representatives in Congress, or members of our judiciary. I wish myself to gratefully acknowledge the many valuable suggestions and criticisms which I have already received from members of the bar and of the bench, with whom I have discussed the subjects of this report.

But with all that has been said and done it still remains for us to take the active initiative. As one very well known and able member of the bar has put it:

"Reform of the patent system, in my opinion, must come from knowledge and action on the part of inventors, engineers, manufacturers and the public. The bench and bar are inert, but they can be galvanized into action."[8]

[8] "Patents and Industrial Progress," by William Macomber, *North American Review*, June, 1910.

The Sketching of Mechanism in Designing*

Much Time and Trouble May Be Saved by Judicious Methods

By Ford W. Harris

The usual method of designing mechanism is to let the designer lay it out himself or a competent draftsman do it under his supervision. The technique of mechanical drawing is well understood and very little can be said at this late day about the special methods that have been developed for making accurate and economical layouts. It is sufficient to say that a good layout is an accurate drawing which shows the essentials of the device to be detailed without going into all the details and without attempting to produce anything ornamental. It is a drawing reduced to its lowest terms. Most inventors start with such a layout, generally made for them by a draftsman.

The writer has to date placed about fifty patent applications in the Patent Office, and about thirty patents have issued, nearly all of which are for mechanisms, and perhaps a brief description of his methods of inventing a mechanism may be of interest. They have been developed during sixteen years practical experience on such work, during which time the general methods outlined have been applied to work varying from a ladle tilt in a steel mill to a regulating mechanism of an arc lamp. It is probable that they do not differ greatly from those used by other men in the same work, but the writer does not remember ever seeing such methods described and, although he has been associated with a number of inventors, he does not remember any man who have developed the system quite as fully as he has. The completeness of this development is due to one fundamental belief that may as well be expressed as a starter.

This belief is that no man calling himself a designer should ask another to draw something that the designer has not satisfied himself in advance is possible and very likely to be practical. This is at variance with the practice of many designers who make a very rough sketch or do what is worse, describe what they have in mind and let the draftsman worry it out. This is very economical of the designer's time as it leaves him free to carry on other work, but it is wasteful of the draftsman's time, and generally results in inferior designs. It is the writer's opinion that the designer should personally carry his work to such a point that the draftsman can go ahead and complete the work with very little help or attention from the designer, and further, it has been demonstrated that if the designer will so handle his work the result will be a considerable saving in cost, considering both the designer's and the draftsman's time.

To do this the designer must roughly lay out the work himself and satisfy himself that what he has in mind will go together. This can be done by the usual drawing office methods, but such methods are too accurate and slow for the purpose in mind. What is desired is a collection of sketches and a description or specification that the draftsman can take and go ahead on, without having to lay out a half-a-dozen schemes before he finds an acceptable one. Of course, designs are generally the work of a number of men, but the original inventor will find that if he digests his schemes pretty well before he starts to get others working on them he will generally carry them pretty near to perfection, and the time of the others will be saved.

It may be necessary to spend a lot of time and hard thought to do this, but very little that is good in engineering comes easy. It will be found that the excellence of any design is a direct function of the time and hard work that has been put upon it. It is not possible to dispense with the draftsman's layout and such a layout will probably disclose difficulties that the sketches will not discover, but such difficulties will be very much smaller in number and of a very much less important character than when the draftsman starts out with only a very hazy idea of what is wanted and the designer has even less accurately defined notions. It is merely a practical application of the old principle that whatever is worth doing at all is worth doing well.

If the design is a hard one it is very unlikely that a satisfactory solution can be found without several trials. If these are made on the drawing-board it will take a lot of time, while by using the sketch method the impracticability of the simple solutions will be quickly apparent and they can at once be discarded without serious expense or what is often of more importance, serious delay.

A man who is going to dig in hard with his brain should have as little strain on his body as possible, and it is a pretty hard job physically to bend over a drawing-board. It is preferable to do the work at an ordinary desk in an ordinary swivel chair which is about as comfortable a position as can be devised. This at once eliminates big sketches, and it is desirable to make them standard letter size which is generally regarded as $8\frac{1}{2}$ by 11 inches. Secondly, it is desirable to use a cheap grade of stationery; the writer uses cheap white typewriter paper for the preliminary work, and tracing linen for the final result. The paper sketches are finally thrown away. The final result is valuable, and it is desirable to save it as it is of value in patent litigation so that the very best is none too good. Intermediately a few sheets of tracing paper will come in handy, but such paper is perishable, tearing easily, and a thin bond paper is much better.

Many designers use ruled cross-section paper, which has two objections: First, it is expensive, and second, after the sketch is made it is better to put in a few main dimensions and not have cross-section lines to confuse the lines of the sketch. It is preferable to make an underlay sheet on tracing linen and use ordinary paper, laying the cross-sectioned underlay under the white paper, and thus have the cross-sectioned lines to make the sketch by but not have them on the sketch itself. Do not use a fine cross-section; the writer finds that half-inch squares give excellent results. Quarter-inch squares are also good, and two sheets, one ruled in halves and the other in quarter-inch squares, will serve to lay out almost any sort of a small mechanism.

The first thing necessary is a sketch of the fundamentals to give a rough idea of the best arrangement of parts. This the writer ordinarily makes on a poor grade of paper and does not bother about the underlay. All that is needed is a qualitative idea of the mechanism without much regard to size of parts, interferences or details of construction. It is not always easy to draw this first sketch, and one can spend much time in groping around for an inspiration. The best way to do, then, is to seek for inspiration from similar mechanism. We are all of us moving by slow steps and he is indeed a conceited man who will not admit that much of the fine work he puts out was borrowed from the long procession of similar designs that have gone before. It is a good principle to take your own wherever you find it, and if some one has seen it first so much the more credit it is to them. This is, of course, to be modified by considerations of general principles

* Reproduced from *Machinery*.

of business and common honesty, but in general there is no such thing as an ownership of mechanical combinations, or at best only a limited ownership for the term of a patent.

After having produced a rough sketch that looks meritorious, it is advisable to make a sketch showing the principal parts to scale within the limits of free-hand sketching. Here is where the underlay and the thin bond paper come in handy. A small pine board and a celluloid angle with a few thumb-tacks are all the drawing instruments needed, and with the underlay sheets and these accessories quite presentable sketches may be made. Pin the bond paper down to the board with the underlay under it and draw in the principal parts with a soft pencil without bothering about one part cutting off the view of another. That is, lay in every piece as if it were the only piece on the sheet and do not bother about dotting or omitting lines that would not appear on a true view of the mechanism.

Before going very far, the designer will begin to wonder what is going to happen when some of the parts assume another position than that in which he is drawing them. The best way to find out is to take a scrap of tracing paper or linen and make the part on this separate piece. This scrap can then be slid around and its action noted. It may be desirable to preserve a record of such positions and a separate sheet of bond paper may be started to show the relation of the mechanism at various points, a separate sheet being generally used to show each position. No attempt should be made to show fastenings.

After a lot of juggling the design begins to breathe or it doesn't. If it doesn't it is generally best to make a fresh start, preserving the papers and the scraps pending the failure or success of this start. After several trials a layout will be evolved that seems to be satisfactory. It is now in order to make the final sketches from the several sheets and scraps that have accumulated. Take a sheet of tracing linen and a soft pencil and trace in free-hand from the scraps the various parts with due regard for their position, dotting important hidden lines and omitting unimportant ones. This final sketch is made only partly for the information of the draftsman. Its chief value is to show whether the work will stand the test of an assembly sketch. Very often it will not and the designer will have to make a fresh start or modify his sketch to avoid the difficulty.

When the designer is through he should have some pencil sketches on letter size tracing linen that fully express the work that he has done. Very often he will do in a few hours what would take as many days to accomplish working cut-and-try with a draftsman, and the chances are that he will have applied himself so that the quality of the work is much better.

Soil Sterilization*

Wanted—Cheap Antiseptics for Use in Horticulture and Agriculture

By E. J. Russell, D.Sc., Director of Rothamsted Experiment Station, England

Recent investigations made at the Rothamsted Experimental Station have shown that antiseptic substances may, under proper conditions, considerably increase the productiveness of soils, and there seems to be a prospect that large amounts could be usefully employed in horticulture, and if the price fell low enough, in certain branches of agriculture also.

The function of the antiseptic is to simplify somewhat the micro-organic population of the soil. A soil kept in a glass-house during a whole season, well watered, manured, and at a temperature distinctly above that normally obtaining outside, soon becomes inhabited by a great and various crowd of organisms. Especially is this true of commercial houses run at a high pitch to obtain maximum crops and subject to invasion by organisms from remote quarters of the globe. Growers of cucumbers, for example, who are perhaps the most intense cultivators in the country, buy quantities of stable manure and other refuse from London to fertilize their borders. This often contains all kinds of imported material, banana skins, orange peel and the innumerable trifles rejected by the city, many of which are capable of carrying spores from their country of origin. Once any of these undesirable aliens get introduced it spreads rapidly, for the conditions of the industry rather favor a transfer of pests from one house to another.

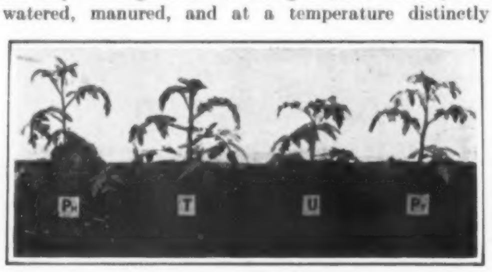


Fig. 1.—Tomato Plants Growing in Soils Treated With Small Quantities of Antiseptics.

U = Untreated soil. T = Soil treated with toluene. Ph. = Soil treated with phenol. Py. = Soil treated with pyridene. The soils were initially all alike; the plants were sown on the same day, and all treated alike. The antiseptics caused very considerable crop increase.

In consequence, the soil used for cucumber growing is thrown away at the end of the year and its valuable manurial residues sacrificed. A new lot is brought in, often at considerable expense, which is justified only by the consideration that the new soil is free from many of the disease organisms. In the picturesque language of the practical man the old soil is "sick" and is therefore rejected.

A second factor in soil sickness lies in the lowered efficiency of the micro-organisms in producing ammonia and nitrates. This has been traced to the abnormal development, under the circumstances of glass-house cultivation, of groups of organisms detrimental to the ammonia-producing bacteria.

The horticulturalist cannot afford to deal with a wholly sterilized soil free from all micro-organisms. The manures that he uses are not, as a rule, plant foods, but have to undergo decomposition and hydrolysis before they are reduced to compounds sufficiently simple to be taken up by plants. Of course he could grow his plants with the aid of sodium nitrate or ammonium sulphate alone, but this course, although possible, is not as convenient in practice as the addition of more complex compounds which undergo bacterial decomposition in the soil.

Fortunately the food-making organisms are on the whole less easily killed than the harmful varieties, and a certain degree of soil purification can therefore be effected by treatment with antiseptics or by heating to a temperature somewhat below 100 deg. Cent. Such treatment is commonly followed by an increased amount of plant growth and a healthier plant growth; bacteriological investigations show also that the numbers of bacteria have increased, and chemical analysis shows a marked increase in the rate of production of ammonia in the soil.

It is not our present purpose to discuss the scientific problems involved but to direct attention to the cultural experiments. "Sick" soils from several large nurseries were treated with various antiseptics or by heat and then sown with crops; the untreated soils gave poor, diseased crops, while the treated soils gave larger and healthy crops. Large scale experiments have shown that the treatment is perfectly feasible for the practical man, but they have brought out several difficulties which, however, ought not to be beyond the power of the chemist to overcome.

When a "sick" soil is heated by steam to 98 degrees it entirely regains its original productiveness, in fact, it commonly does more because of the decomposition that has taken place. Treatment with antiseptics has so far not proved so effective. In testing the effect of various antiseptics we therefore have a definite and hitherto unattained standard to aim at. The general conclusion of our work up to the present time is to place the antiseptics in the following order of effectiveness:

Class I. (The best antiseptic although not as good as steam).—Formaldehyde, pyridene, collidene and lutidene (i. e., the fraction containing the higher bases).

Class II. (Less effective).—Benzene, calcium sulphide, carbolic acid, cresylic acid, "light solvent naphtha," heavy solvent naphtha (i. e., homologues of benzene), gasoline, toluene.

Class III. (Least effective).—Naphthalene, and certain derivatives obtained during its isolation.

As nearly as possible this is the absolute effectiveness, all subsidiary questions such as difficulty of application or distribution in the soil being obviated. The order in the various classes is alphabetical only, the experiments hardly being numerous enough to justify closer differentiation.

The antiseptics in the first class proved very useful. They killed the disease organisms, the eelworms (*Heterodera*), the damping-off fungus (*Pythium*), etc., and they conditioned a satisfactory increase of bacterial numbers and of plant food.

The antiseptics in the second class were not so good in either direction and consequently gave less increase in crop.

There is no short and easy way of ascertaining the absolute effectiveness of an antiseptic. Our experiments have invariably consisted in five series. Part of the soil is treated with 0.1 per cent of antiseptic, part is heated for an hour to 95 to 100 deg. Cent., while the remainder is left untreated, and then:

(1) Chemical analyses are made at periodical intervals extending over a month, to ascertain the rate at which ammonia and nitrates accumulate in the treated and untreated soils.

(2) At the same time bacteriological counts are made by the gelatine plate method to ascertain the rate of development of bacteria.

(3) Some of each lot of soil is inoculated into test tubes containing sterilized hay infusion, and after six days' incubation drops of the infusion are examined under the low power of the microscope for protozoa. If these organisms are killed by the treatment, it commonly happens that other harmful organisms are killed also.

(4) Seeds are sown in the soils and the young plants are carefully watched to observe the development of "damping-off," root knots, or other diseases.

(5) Plants are grown right through to fruiting, and the produce weighed.

The results of all the series are usually concordant, but it is not safe to dispense with any of the five, and we should view with suspicion any results so obtained. For preliminary sorting out (1), (2) and (3) give useful results in a short time and without requiring any special apparatus. But for final examination of an antiseptic all five are needed. It is essential to the proper carrying out of the experiments that the treated and untreated soils should be stored under similar conditions of moisture, temperature and reaction, and this can most conveniently be accomplished by allowing the excess of antiseptic to evaporate as far as it will, then making up the soils to uniform moistness, and finally putting up 800 gramme lots in clean liter bottles and plugging with sterilized cotton wool.

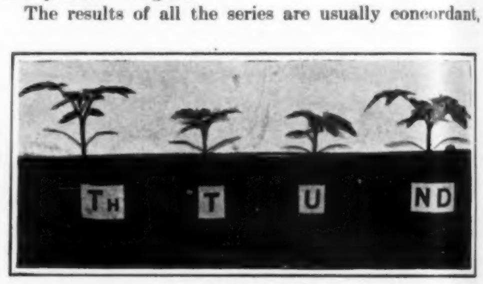


Fig. 2.—Effect of Small Quantities of Antiseptics on the Soil.

U = Untreated soil. T = Soil treated with toluene, the effect being much less than in Fig. 1. Th = Soil treated with thiophen, the effect being very marked. ND = Soil treated with a residue obtained during the purification of naphthalene.

The absolute effectiveness of an antiseptic having been ascertained in comparison with one or two of the substances in the list just given, the next step is to determine the ease of distribution in the soil. Like other colloids, soil has the remarkable power of withdrawing many dissolved substances from their solutions. It is therefore unsafe to argue that an antiseptic can be mixed with the soil simply because some gallons of its solution are easily watered on to the surface. Some of the antiseptics in the second class (e. g., carbolic and cresylic acids) are fairly readily abstracted in this manner, so that if a solution is poured on to a layer of soil 3 inches in thickness (e. g., contained in a Buchner funnel), the percolating water may be practically free from the antiseptic and the bottom layer of soil remains unaffected. From this disadvantage the vapors (formaldehyde, carbon, disulphide, etc.) are free, but if they happen to be only sparingly soluble in water, they do not readily penetrate. Calcium sulphide also does not appear to suffer in this way. All substances are not equally affected, and some soluble materials will pass fairly readily into the soil. It is not necessary that the material should be wholly unabsorbed; the soil is mixed up to a considerable extent by the cultivation processes and a certain amount of distribution is thereby effected. But it is undesirable

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that absorption should be too complete, or the distribution becomes too local for the best results to be obtained.

A further important point is that the antiseptic must disappear from the soil after its work is done. This may come about in several ways. The low boiling substances simply evaporate. Calcium sulphide and bleaching powder decompose, leaving among their residual products a certain amount of valuable calcium carbonate. Carbolic acid, cresylic acid, and apparently other allied compounds are slowly oxidized by bacteria, a wholly remarkable change which deserves fuller investigation. Pyridene also is decomposed. Only an actual experiment avails to determine whether the antiseptic persists in the soil long enough to injure the young plant.

As only cheap substances are likely to be used, it is clear that some waste product is indicated. There must be many such products available. Solids would no doubt be most convenient, but liquids that are soluble or miscible with water, or could be made so by suitable admixtures, would also serve the purpose. Nitrogen compounds would possess an added advantage that they may decompose to yield plant food. Experiments indicate, however, that some degree of standardization is necessary and that the effect of the separate constituents of the mixture should be known. Thus, it was found that samples of commercial toluene, which appeared to be fairly similar, differed pretty considerably in action. Later work showed that thiophen was a very potent agent, and left no doubt that variations in the amount of this impurity had caused the discrepancies observed. And further, the grower would probably not hesitate to put in a claim for compensation if any product supplied to him had done actual damage.

These are the difficulties the works chemist would be called on to deal with; that they are not insuperable is shown by the action of several enterprising firms in putting out soil antiseptics. There seems little doubt that, given suitable antiseptics, the chemical treatment of soils is likely to develop considerably.

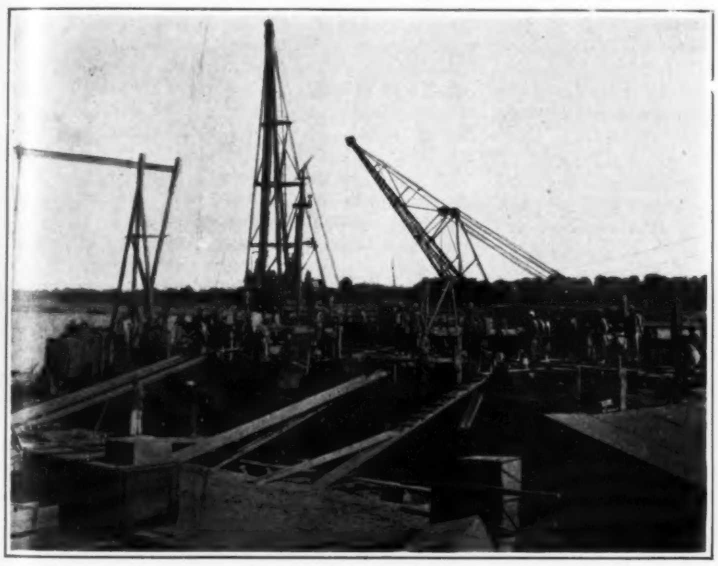
A Chinese Railway Bridge

Spanning the World's Most Treacherous River

By F. C. Coleman

The northern (German) section of the Tientsin-Pukon railway has recently opened to traffic a new bridge over the Hwang Ho. This river, which is one of the principal waterways of China, originally flowed eastward to the coast 650 miles distant, but in 1851-3 this wayward and turbulent stream, which is said to have shifted its course nine times in 2,500 years, turned off north-eastward near Kaifung-foo. Since then it has discharged its waters into the Gulf of Pechili, 321 miles north-northwest of its former mouth, the mountainous province of Shantung lying between the two. In some parts of its eastward course the river bed of the Hwang Ho is above the great plain through which it passes, and the embankments have been a source of never-ending expense and their yielding to floods a frequent cause of desolation to extensive districts. In its course through Tibet, Mongolia and China, the Hwang Ho touches lands, in the provinces of Shan-hsi and Shen-hsi, which consist of loess, and the vast quantity of sediment conveyed to the sea by this river gives to it and to the sea in which it empties itself its yellow color and hence its name, "Yellow River." The site of the new bridge is about 660 feet from its mouth and here the Hwang Ho measures at low water 1,320 feet, while at high water the distance between the south and north high-water dams is 7,260 feet. The land liable to inundation on the north bank is 6 to 9 feet higher than low-water level, while there is a difference of 9 to 15 feet between low and high-water levels. On the south side the high-water dam is approximately at low water level. At low water the river deposits considerable quantities of sand in its bed, which, at rising tide, when the current increases in speed, disappears again in a few hours. The speed of the current at the site of the bridge is 13 to 16 feet per second, or nearly 9 miles an hour, and it is clear that obstructions in the river way —and as such piles would be regarded—would cause scour. In the construction of the bridge the foundations were taken to such a depth that scour must be considered as impossible. In order to secure to a greater extent the deposited strata of the Hwang Ho and also the piles and to prevent the ravages of the flowing water, the piers which lie between rammed piles, were surrounded by stone pitching.

With the exception of the pier which stands in the middle of the stream, the whole bridge is carried by reinforced concrete piles. The number of these is such that even in the event of scour as far as the foundation base, the piles themselves will be able to safely bear the bridge, even under heavy traffic. At the abutments and the piers to approach spans, where the water covers them only at high tide, and then only with a low velocity, the reinforced concrete piles have a length of 50 feet. The bottom of the foundations lies 20 to 24 feet below the river bed, and the piles were driven 42 feet below the foundations.



The Pile Driver at Work.

View Looking Along the Line of Piers.

The work was carried out by excavation and the use of sheet piling. The river piles are exposed to a much stronger and more frequent attack from the current, and according to observations made during the building and the experience gained the bottom foundation was taken 56 feet below low water. Under the bottom of the foundations the reinforced concrete piles (56 feet in length) were here rammed down 26 to 83 feet. The piles were sunk by means of caissons strongly braced and ballasted with concrete. These were then taken 43 feet below low water, and, being 46 feet high, still projected above water. On the upper end of the caisson a pile driver, the ram of which weighed 4½ tons, was erected. The pile driving proved to be a particularly slow and troublesome work because not only did the loess prove to be very hard, but the ground became compressed by the driving in of the piles and these advanced only by millimeters under the blow of the ram. After the stake driving, the ground between the stakes was taken out and the caisson sunk 4 feet deeper. In this way three river piers were built. For the fourth, which stands in the middle of the stream, for various reasons which asserted themselves during the building, another method had to be employed. The piles were entirely left out in this case and the pier was taken down 82 feet below low water so that at that place with a depth of water of 16½ feet it stands 66 feet in the river bed.

The sinking work of this pier as well as of the three others was undertaken by means of compressed air. For the piers in the middle of the river the pressure upward rose to two and one half atmospheres and made short working periods necessary. During the building of the pier in the middle of the river, the Hwang Ho showed herself in her most dangerous mood, as, when the scaffolding for the staying and sinking of the caisson was almost ready, she rose to the highest water mark recorded during the whole of the time of building and, later, just when the first work of the piers began, there was a powerful flow of ice, the river finally becoming frozen over so that passengers and carts traveled over the ice.

For the erection of the sub-structure extensive use was made of rammed concrete, especially for the foundation and masonry work, the exposed surface of the latter being covered with limestone and the piers faced with stone. The bearings are carried upon granite blocks. Between abutments, the bridge has a length of 4,120 feet. This comprises the river bridge, which is divided into two side openings of about 420 feet span, and a middle opening of 540 feet span; and the nine flood approach bridges, each with 300 feet span. One of the latter lies on the south, and eight on the north bank. The approach spans are simple parallel girders, while the middle span is a cantilever with a suspended span of 360 feet. The top chord of the middle span is carried high above the middle piers, which lends a pleasing appearance to the bridge. The permanent way on the main span is level, the rail upper edge being 44 feet above low water. The approach spans connecting on both sides of the cantilever opening have a fall toward the abutments of 1 in 150. Some unusual difficulties presented themselves in the design. The railway authorities required a single-track bridge which could at any time be converted at a minimum cost into a double-track bridge. This consideration was met as follows: The distance between the main girders was so chosen beforehand (31 feet) that two of the cantilever arms as well as the approach spans of the river bridge were effected by means of falsework, and the middle opening on the north was completed by the cantilever arrangement. This method was found necessary because the building in of the falsework in the main stream would have produced a contraction of area which would have been dangerous to the falsework itself. This work ranks as one of the most important bridge contracts ever carried out in the Far East, and the bridge is one of the longest in any part of China. After having been under construction a little over three years the bridge was formally opened to traffic in December last.

The total amount of the steel work was 8,700 tons, of which 3,700 tons were used in the main span and 5,000 tons in the flood bridges.

Peroxides and Per-Salts—I

Their Preparation, Properties and Uses in the Arts and Industries

By A. S. Neumark

I. Hydrogen Peroxide.

The oxidizing, bleaching and disinfecting properties of hydrogen peroxide have long been known. Yet the surprising development only within recent years in the industry of certain metallic peroxides and per-salts depends on just these properties. What is new on this group of oxidizing compounds is merely the form in which the active oxygen is put up and the innumerable uses that have been found for them in medicine, the arts and industries and in the chemical laboratory.

Hydrogen Peroxide, H_2O_2.

Hydrogen peroxide has been known since 1818, when it was for the first time prepared by Thénard by the action of acids on barium peroxide. It occurs in small quantities in the air, especially after a thunder storm, and is present in rain and snow, but not in natural dew. The presence of hydrogen peroxide in rain is due to the action of ozone on water, the former being formed by the influence of the silent electrical discharge on moist rarified air in the upper region of the atmosphere. It is also claimed that ultra-violet light is one of the causes of the presence of hydrogen peroxide in rain water. The bleaching action of the sun's rays (in lawn bleaching) is due solely to an oxidizing effect. K. W. Charitskow has proved that the rays of the sun are capable of producing hydrogen peroxide, by exposing moist porous substances to the sun in the presence of oxygen. Hydrogen peroxide has also been found present in certain plants, such as tobacco leaves, vine, lettuce, and is formed by slow oxidation of essential oils in the presence of air and water, especially if the materials are kept warm. Kingzett[1] calculates that the eucalyptus forests of New South Wales and South Australia alone contain at any moment enough oil in the leaves, ready to be evaporated into the atmosphere under the agency of warm winds, to form no less than 93,000,000 tons of hydrogen peroxide and 507,000,000 tons of camphoraceous products. According to Kernbaum,[2] water is decomposed by ultra-violet rays into H_2O_2 and hydrogen; a like action is exerted by the beta rays of radium.

Methods of Preparation.—Hydrogen peroxide may be prepared in many ways:

1. By decomposing the peroxides of alkalies and alkaline earths with dilute acids.
2. By electrolysis of water acidified with sulphuric acid at low temperature.
3. By the action of ozone on water in the presence of nitrogen or an oxidizable substance.
4. In small quantities by slow oxidation of many metals in the presence of water.
5. By exposing ether to air in the presence of water.
6. By directing a jet of steam on a hydrogen flame. Franke suggests the preparation of H_2O_2 by directing flames of carbon monoxide or hydrogen (illuminating or water gas) against cold water.
7. According to E. H. Riesenfeld, H_2O_2 is formed at the anode in the electrolysis of potassium hydroxide; sodium hydroxide does not form any H_2O_2.
8. Dr. F. Fischer[3] produces H_2O_2 by blowing dry or moist air against an electric spark or arc.
9. By the action of concentrated sulphuric acid on dry persulphates.
10. By shaking zinc amalgam with alcoholic sulphuric acid in the presence of air.

Manufacturing Methods.—For the technical production of H_2O_2, barium peroxide BaO_2 is almost exclusively used. Many improvements have been made to render the process economical, but most of these are kept a secret by manufacturers. Some of the processes that have been employed are given below.

A current of carbon dioxide is passed through ice cold water, and the finely powdered barium dioxide is added gradually in small quantities. The reaction taking place may be expressed by the following equation:

$$BaO_2 + CO_2 + H_2O = H_2O_2 + BaCO_3.$$

The precipitate of $BaCO_3$ is removed by filtering. If the gas is in excess, barium percarbonate is formed. Or hydrochloric acid may be employed in the decomposition of barium dioxide (or its hydrate).

$$BaO_2 + 2HCl = BaCl_2 + H_2O_2.$$

The dissolved barium chloride is percipitated by sulphuric acid, as insoluble barium sulphate. A better way is to use sulphuric acid to decompose the BaO_2. The latter is previously soaked in water to remove caustic barium oxide, then passed through a fine sieve and made into a paste. This is gradually stirred into a dilute solution of sulphuric acid, the temperature being kept at 15 deg. Cent. A small quantity of hydrochloric and phosphoric acid should be added. When the solution is nearly neutralized, it is advantageous to introduce enough sodium phosphate to replace the sulphuric acid by phosphoric acid, as the latter improves the keeping qualities of the H_2O_2 solution. A method frequently used is to decompose barium dioxide with hydrofluoric (HF) or silico fluoric (H_2SiF_6) acid. The preparation of hydrogen peroxide from barium peroxide and hydrofluoric acid is carried out as follows: Into a solution of 30 pounds of hydrofluoric acid in 16 gallons of water is gradually stirred a paste made of 30 pounds barium peroxide and 4 gallons of cold water until the liquid is slightly alkaline; barium fluoride and H_2O_2 are formed. Acid is then again added, until an acid reaction is shown, the liquid kept in agitation all the while. When the addition of acid is completed the materials are left to stand over night. The insoluble barium fluoride settles down and the clear H_2O_2 solution (10 per cent strength by volume) is drawn off. The hydrofluoric acid may be recovered from barium fluoride by treating with sulphuric acid. In all processes in which barium dioxide is used only a dilute (3 per cent) solution of hydrogen peroxide is obtained.

Sodium peroxide is occasionally employed for the manufacture of H_2O_2. According to Dony, sulphuric acid is added to the solution, and the sodium sulphate formed is thrown down with denatured alcohol (10 per cent), the liquid being kept at a temperature of 10 deg.

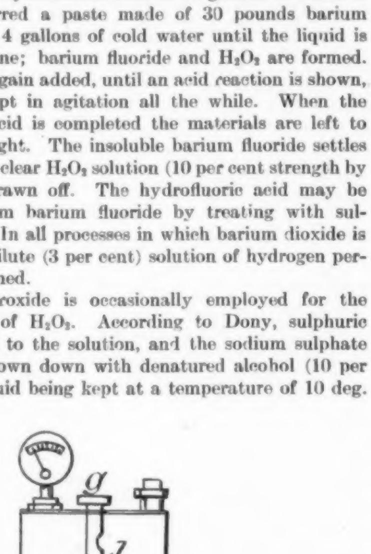


Fig. 1.—Generator for Producing Oxygen from Hydrogen Peroxide.

Cent. Merck obtains a highly concentrated product by direct distillation of a solution obtained by the action of sulphuric acid on sodium peroxide. Technical hydrogen peroxide is also obtained by electrolytically preparing persulphuric acid and subjecting it to distillation. Pietzsch and Adolph[4] prepare the peroxide by distilling a mixture of sulphuric acid and a persulphate, the active oxygen of the latter passing over as H_2O_2 in nearly theoretical amount. The product is of high concentration.

Properties of H_2O_2.—Pure hydrogen peroxide is a colorless, syrupy, inodorous liquid of specific gravity 1.49 at 15 deg. Cent. The concentrated liquid reacts acid toward litmus, the diluted solution, however, shows a neutral reaction. H_2O_2 is miscible with water in all proportions, and in the *pure* state is perfectly stable. Heating, violent agitation, or the presence of alkalies and certain metallic or other substances (catalytic agents), however, cause its decomposition into active oxygen and water. One volume of H_2O_2, if decomposed, yields 478 times its own volume of free oxygen in the nascent state. By rapid heating or by contact with certain substances in a finely divided state (such as silver oxide, lead peroxide, manganese dioxide, platinum, silver, etc.), decomposition may be increased to explosion. Hydrogen peroxide is not only a powerful oxidizer, but in several cases also acts as a reducing agent. Thus lead peroxide is reduced to the oxide: $H_2O_2 + PbO_2 = H_2O + PbO + O_2$. Technical H_2O_2 always contains impurities, such as traces of ferric, manganic and aluminium oxides, together with some silica, and is therefore unstable in concentrated solutions. The commercial solution of H_2O_2 usually contains 3 per cent of H_2O_2 by weight (commonly known as "10 per cent by volume") solution. This strength has been found the most economical, as the loss from decomposition and the cost of production is higher in proportion for the higher strengths. The solution always contains a small amount of free acid, purposely allowed to remain in it as a preservative. For the same purpose the addition of 1 gramme of naphthalene per liter has been recommended by Zinno; Zunder recommends the addition of 2 per cent alcohol or ether; phosphoric acid, sodium pyrophosphate and sodium chloride also improve the keeping quality of the solution. Other substances which have been recommended and are being used as preservatives are: Thymol, menthol, glycerine, quinine, acetamid, acetanilid, uric, sulfanilic, tannic, gallic and pyrogallic acid; dextrin, tragacanth and gum arabic. Tight closure does not prevent decomposition, and may only lead to dangerous pressure in the storage vessel, caused by disengagement of oxygen. The solution should never be exposed to light or heat; for medical or household purpose, yellow glass bottles should be used.

Since the small quantity of alkalies contained in glass is sufficient to impair the stability of H_2O_2, it is advisable to use paraffin or ceresine-coated glass containers. Metallic vessels must never be used for storing H_2O_2 solutions, unless they have previously been well coated with amber varnish or paraffin wax; earthenware or wooden vessels or well-tarred casks are also suitable. Pietzsch and Adolph recommend vessels made of aluminium or alloys of aluminium. While most hydrogen peroxide solutions which occur in commerce are of 3 per cent strength, more concentrated solutions are being put up. Merck's "Perhydrol" is an exceptionally pure product, containing 30 per cent by volume of H_2O_2. By careful evaporation on the water bath, the 3 per cent solution may be concentrated up to 45 per cent. If the solution thus obtained is extracted with ether and then evaporated, it may be still further concentrated and may even be obtained in crystals. R. Wolffenstein prepared practically anhydrous H_2O_2 (containing more than 99 per cent H_2O_2) by first removing all traces of dust, heavy metals and alkali from the commercial 3 per cent solution. It was then concentrated in an open vessel on the water bath until it contained 48 per cent H_2O_2 when the solution was distilled under diminished pressure.

Uses of Hydrogen Peroxide.—Hydrogen peroxide is extensively used for various scientific and industrial applications and in therapeutics. It is used in the chemical laboratory for oxidation purpose, and for qualitative separations in analytical chemistry. Occasionally it is also used for the production of pure oxygen. A generator for this purpose which delivers oxygen under pressure has been devised by Dr. Silverstein. The apparatus consists of two vessels, *a* and *b* (see Fig. 1), connected with each other by means of a tube *c*. This tubing also serves for the introduction of the catalytic substance and is provided with perforations *f* in the upper vessel. It can be unscrewed, allowing the lower vessel to be filled with hydrogen peroxide. A 3 per cent solution is used and the vessel is filled with it completely. The stop cock *m* is closed and part *b* screwed into position. The cap *g* of pipe *c* is removed, a catalyser pellet introduced and the cap replaced. Liberation of oxygen begins at once, the gas collecting in *a*; on opening valve *m*, some liquid is forced out of the tube *p*, until the H_2O_2 sinks below the pipe attachment *d*, when pure oxygen (free from admixture of air) escapes through the delivery pipe.

It is well known that nascent oxygen is the most powerful and most rational antiseptic, antizymotic, sporicide and germicide known, and hydrogen peroxide with its metallic salts is the readiest and most reliable source of oxygen yet discovered. The extended use of this preparation in medicine has earned for it a place in the U. S. Pharmacopœia since 1890, when the 3 per cent standard was adopted. The active oxygen in H_2O_2 attacks every form of pathogenic germ-life, pus, decaying organic matter or foul secretion. It has been found useful in the treatment of ulcers, abscesses, bed sores, gangrene, eczema, erysipelas, scabies, scurvy, stomatitis, tonsolitis; insect bites, blood poison, wounds and burns. It is further used in conjunctivitis, as a mouth wash and as a nasal douche in catarrh of the nose. A spray of a 1 per cent solution is useful in the treatment of hay fever; it not only acts as a disinfectant, but also mechanically

[1] *S. Rideal*, Disinfection and the Preservation of Food.
[2] *Compt. rend.* 149, 116, 273.
[3] Ger. pat. 228,425 of 1909.
[4] Eng. pat. 23,060 of 1910.

cleanses the nasal mucuous membrane. Peroxide of hydrogen also gives relief in many forms of toothache and is used as a local styptic. It is valuable in surgery for disinfecting the hands and instruments, is employed in the treatment of profuse suppurations of wounds and is particularly useful for loosening crusts in wounds. It forms an excellent medium for the detachment of adhering surgical dressings which, with the aid of H_2O_2, may be removed without causing hemorrhage or pain. The injection of a 3 per cent solution is very efficacious in the treatment of fistula. Registered names for hydrogen peroxide solutions are Perhydral, Dioxogen, Hydrozone, Glycozone, Pyrozone, etc. Althoefer recommends the application of H_2O_2 for household use as a protective measure during any epidemic of typhoid fever or cholera, by adding 10 cubic centimeters of a 3 per cent solution to 1 liter of water. Ozonic ether is an etheral solution of H_2O_2, which has been used in whooping cough and scarlet fever. Since hydrogen peroxide is absolutely harmless, it may be taken internally, or inhaled in form of a spray or vapor. It has been recommended in the early stages of pulmonary tuberculosis, in low fevers and whooping cough, in diabetes, and as an antiseptic and antiferment in the treatment of digestive disorders. Oxygar is a preparation whereby H_2O_2 is combined with agar-agar; it is intended for internal administration, especially in gastric and intestinal troubles. Dr. Richardson proposes to saturate H_2O_2 with iodine, to add 2½ per cent of sea salt, and to use the mixture as an antiseptic spray in an atomizer. Hydrogen peroxide solution forms an excellent dentifrice; it sweetens the breath, relieves bad taste, hardens the gums and prevents the accumulation of tartar on the teeth. As a toilet preparation it will be found valuable in removing pimples, freckles and blackheads and is perhaps the best and most harmless depilatory. Albin is a preparation containing gypsum and H_2O_2 and is used as a tooth paste as well as a polish; an efficient toothpaste may also be prepared by mixing hydrogen peroxide with a thick solution of starch and then adding enough chalk to obtain the desired consistency. Mixtures of H_2O_2 with certain disinfectants such as menthol, thymol, camphor, phenol, salicylic acid, quinine-sulphate or zinc chloride are known in Germany under the name of *peroxals*. Forensic medicine has benefited by a discovery of Cotton, who showed that the 3 per cent solution of H_2O_2 furnishes a means of differentiating human from animal blood, since the former evolves in the presence of H_2O_2 a considerably larger proportion of oxygen than animal blood.

Upon the fact that H_2O_2 readily parts with its oxygen when brought in contact with substances, which can take up the latter, is based its value as a *disinfectant*. When brought in contact with organic matter, it oxidizes it, thus destroying its vitality. In this way bacteria and other germs are killed. It has no effect on foods (such as albumen, casein, milk, eggs, fats, sugar and juice of fruits), and is innocuous and non-corrosive, which properties suggested its use for killing pathogenic organisms and those that cause change in articles of diet. Hydrogen peroxide is one of the few disinfectants which have no effect on digestion and yet attack bacterial germs. It could be called the disinfectant *par excellence* if it were quicker in action and were it not that in cold solutions its action is somewhat feeble. The latter fact also makes it unsuitable for sterilizing drinking water; large doses of H_2O_2 would be necessary for effective sterilization, or else small doses allowed to react for a long period. According to Budde solid foods may be sterilized by soaking in water containing H_2O_2, and heating to a temperature not exceeding 50 deg. Cent. Hydrogen peroxide is also capable of preserving milk and it may be regarded as the only chemical disinfectant that does not change the physical, chemical and biological properties of the same. Complete sterilization may be obtained with 2 per thousand of H_2O_2, while the addition of 1 per thousand and heating to 65 to 75 deg. Cent. is sufficient to preserve milk for several weeks. A. Rosam[5] drank 80 liters (about 21 gallons) of milk thus treated within 100 days, and during this period had taken into his system 1,800 cubic centimeters (about 60 fluid ounces) of H_2O_2 without any noticeable harmful effects. Ed. Bonjean[6] states, that where the preservative was used in proportions of 0.05 gramme per liter before pasteurization, the number of germs had decreased from 500,000-1,000,000 to 16,000-138,000 per cubic meters at the time of pasteurization. Hydrogen peroxide, therefore, aids pasteurization and enables it to be efficient at a low temperature. In France the employment of 0.05 gramme of H_2O_2 is permitted as a preservative, but only when followed by pasteurization, and when the preservative is pure and no traces of it can be found in the milk as offered for sale. Hydrogen peroxide is known to disappear within four hours after pasteurization. The use of H_2O_2 has also been proposed for the rapid maturing of brandy and for removing the moldy taste and odor of spirits.[7] A 5 per cent solution has also been recommended for preserving eggs. Experiments have shown that eggs thus treated can be stored for months at room temperature and still remain free from any unpleasant smell or taste. Etheral solutions of H_2O_2 are being used in photography for intensifying negatives and also for the catalytic copying process suggested by Ostwald and Gross.[8]

Organic coloring matter is transformed and destroyed by H_2O_2. The latter is, therefore, an excellent *bleaching agent* and is used for all classes of fibers as well as for the bleaching of straw, wood, hair, sponges, leather, ivory and similar articles. On account of its high price, the use of H_2O_2 was restricted until recently for bleaching high-priced articles, such as silk, ivory, feathers, etc., and for certain delicate bleaching operations, such as the whitening of the paper of books and the bleaching of engravings or oil paintings that have become stained or dingy with age. It is now, however, used in increasing quantities for bleaching all kinds of fabrics and for removing the last traces of chlorine and sulphur dioxide employed in other bleaching processes. For the bleaching of silks (especially tussah silk) H_2O_2 is preferable to any other bleaching agent known. In the case of cotton and wool H_2O_2, too, would doubtless supersede bleaching powder, etc., if its price were to come down sufficiently. Lawn-bleaching of linen may also be replaced by H_2O_2 and, in fact, this is actually the case. A combined method of bleaching fine cotton yarns with hydrogen peroxide and bleaching soda has of late been introduced which gives a beautiful white product.[9] Heat decomposes H_2O_2, but accelerates bleaching. The bath is always made alkaline either with ammonia (for feathers, bone, ivory, hair) or with silicate of soda (for wool, straw, silks, etc.). In dying hydrogen peroxide is used instead of developing by steaming. Immediate blue may be developed by means of an after treatment with H_2O_2, made alkaline by ammonia. As a toilet preparation for bleaching red or dark colored hair H_2O_2 was first put on the market by Thiellay. All the well-known preparations (Golden Hairwash, Aureoline, Blondine, etc.) used as auricromes, contain as active principle hydrogen peroxide. H_2O_2 is also used as a detergent in chemical bleaching, especially where the usual solvents for stains (benzine, carbon tetrachloride, etc.) fail to produce the desired results and recourse must be taken to bleaching.[9] Stains caused by coffee, chocolate, cocoa and red wine can be removed by repeated damping and gentle rubbing. A mixture of H_2O_2 and ammonia will readily remove stains due to grass, beer, milk, fruit juices. Iron-ink stains are also removed by H_2O_2 provided they have previously been touched with hydrochloric acid; a similar treatment often removes rust and mildew stains. In combination with soap H_2O_2 may also be used for cleaning white gloves. The use of hydrogen peroxide as a cleansing agent is not restricted to the removal of stains from white fabrics, but is also applicable to dyed goods, provided the necessary care be taken.

The use of hydrogen peroxide has further been proposed as a means of judging the quality of flour;[10] the best flour has little or no action on H_2O_2. A very large portion of flour in bread now consumed in England is being bleached by H_2O_2. In the United States as well as in other countries, bleaching of flour is prohibited.

By treating hydrogen peroxide at low temperature with carbamide (urea) a stable composition may be prepared[11] which is of considerable technical importance. This substance forms beautiful colorless prisms which on heating to 85 deg. Cent. are converted with violent evolutions of oxygen into a saturated solution of carbamide.

In the search for disinfectants and oxidizing agents certain compounds of hydrogen peroxide with organic substances have received attention. A body belonging to this class is acetyl-peroxide. Its aqueous solution slowly decomposes with loss of oxygen (more rapidly in the presence of caustic alkalies) and has an intense germicidal action. It does not evolve oxygen on contact with blood or pus as does peroxide of hydrogen, yet it reacts more rapidly on blood than the latter. It is non-poisonous and can be used as internal disinfectant. Compounds, such as urea, acetamide, urethane, etc., also combine with H_2O_2 to form solid substances. By mixing a small quantity of a solid organic or inorganic acid intimately with these substances, very stable and useful compounds are formed. Urea-hydrogen peroxide[12] has the formula $CO(NH_2)_2 . H_2O_2$. This product contains 34 to 35 per cent of H_2O_2, is easily soluble in water and yields hydrogen peroxide much more readily than do per-salts. It is unstable in the pure state, but can be made stable by adding a small quantity of sodium bitartrate, sodium hydrogen phosphate, boric acid, etc.

(*To be continued*)

[5] *Centr. bl. f. Bakt. Parasitenk. u. Infektionskrankheiten,* 1902, p. 739.

[6] *Ann. falsific,* II. 411, 425.

[7] *Chemische Industrie,* 1906, p. 62.

[8] *Chem. Zeit. Rep.,* 1903, p. 152.

[9] *Bottler,* Moderne Bleich u. Reinigungs mittel.

[10] *Chemiker Zeit.* 33, p. 1,137.

[11] French pat. 436,095 of 1911.

[12] Ger. pat. 20,242 of 1911.

Misapprehension as to the Novelty of the Friedmann Treatment

[*The public has followed with much interest the somewhat unsatisfactory developments of Dr. Friedmann's proposed demonstrations of his alleged anti-tuberculosis serum. It is impossible at the present time to form any definite opinion regarding the merits of Dr. Friedmann's treatment. Without prejudice, without partisan spirit, in the neutral attitude of the reporter only, the editorial comment here reproduced from the Journal of the American Medical Association is laid before our readers.*]

In view of the newspaper sensation caused by the announcement by Dr. Friedmann of another "cure" for tuberculosis, it would seem well to review some of the facts previously known. Even editors of medical journals, who should be conversant with the history of medicine and of tuberculosis, have been led into grave error. For example, a recent editorial in a medical journal makes the statement that "Friedmann came to the conviction that the most potent curative and immunizing powers lie in the living bacterial organism itself, and not in the dead organism as used in the method of Wright and his school." The editorial says further, "Our own impression from the entire debate is that Friedmann has enunciated a principle of far-reaching consequence and has probably discovered a remedy that influences tuberculosis favorably." The effect of this editorial is to credit to Friedmann the discovery that in order to produce immunization against tuberculosis living cultures are necessary. For the truth of medical history as well as the credit of American physicians it is well to point out some of the things which were done years ago.

In 1892 and 1893, Trudeau of Saranac Lake demonstrated the fact that subcutaneous inoculation of living cultures of the avian tubercle bacillus greatly increased the resistance of rabbits against infection by virulent mammalian cultures. He immunized rabbits to such an extent that when they were inoculated with virulent cultures, the inflammatory reaction gradually disappeared, leaving the eye in the normal condition, while in control animals the destruction of the eye was complete. As far as we have been able to discover, Trudeau was the first to announce the principle that living cultures must be used in order to produce an efficient immunity against tuberculosis.

De Schweinitz in 1894 immunized animals with human tubercle bacilli which had been cultivated for twenty generations on slightly acid broth. At the end of this time the cultures were not virulent for guinea-pigs, but were capable of immunizing these animals to such an extent that they resisted infection with the bovine germ. Control animals died in seven weeks.

Pearson and Gilliland demonstrated that human tubercle bacilli which were not virulent for cattle would produce a high degree of immunity when injected into the circulation. In 1905 the same authors' demonstrated a strong curative action on tuberculosis from injections of non-virulent tubercle bacilli derived from human beings.

Webb and Williams demonstrated that immunity against tuberculosis could be produced by the inoculation of living tubercle bacilli, beginning with small doses and gradually increasing.

If we go to foreign publications it is easy to multiply instances of the use of living cultures. In 1901 McFadyean not only demonstrated his ability to produce immunity in cattle by the use of living cultures, but also in one case treated an animal which was already tuberculous. The animals resisted for a long time injections of tubercle bacilli of proved virulence for cattle.

In 1901 von Behring announced his method of bovovaccination, the first detailed publication of which appeared in 1902. Living cultures were used.

In 1903 Thomassen reported experiments in which by the intravenous injection of human tubercle bacilli into young cattle he produced a considerable degree of immunity.

Vallée reported experiments in which young animals were rendered highly immune against virulent bovine infection by the use of non-virulent living creatures derived in the first instance from a horse.

Instances could be multiplied, but these are enough to demonstrate that Friedmann has not discovered or announced any new principle in regard to the immunization against tuberculosis. As far as our knowledge goes, he has followed methods which were demonstrated first in this country, and have been confirmed by many workers in America and Europe.

Practically, of course, the point of interest is in the question whether or not a harmless and clinically efficient immunizing culture has actually been worked out. On this point we still await authoritative tests, for we have no information that Dr. Friedmann has yet submitted his treatment to investigation by competent and unprejudiced experts in the treatment of tuberculosis.

Fig. 1.—A Typical Wire Drawing Machine for Heavy Wire.

Fig. 2.—Front and Rear Views of Three Tungsten Steel Draw Plates.

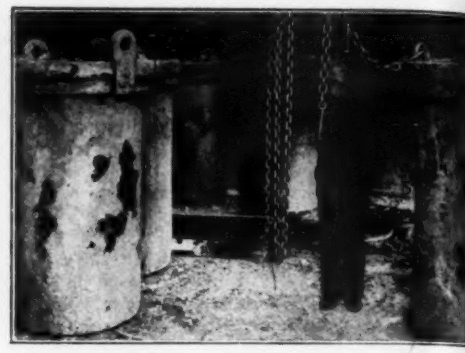


Fig. 3.—A Number of Large Annealing Pots Used in Wire Mill.

Wire Drawing*

Methods and Machines Used in Manufacture

By Erik Oberg

The making or drawing of wire of small diameter has, for centuries past, formed an industry by itself. As the methods used in this industry are comparatively unknown to the average mechanic, a description of them and of the machines used will probably be of interest. On account of the fact that wire drawing is a very old art, many of the methods used have been handed down from generations. Improved machinery, however, has been introduced, and the rapidity and accuracy by which the wire can be produced has been greatly increased during recent years.

The earliest mention of wire drawing is in a historical document which shows that in 1351 there were men engaged in this work in Augsburg in Germany, and it is believed that the art was originated by a man named Rudolph, from Nuremberg, about that time. It is definitely known that in 1370 there was a wire drawing mill in the latter city making wire from a number of different metals. From Germany the art of wire drawing was introduced into England in the seventeenth century. The first wire drawing mill in America was built in 1775 in Norwich, Conn., by Nathaniel Niles, who was granted a loan of $1,500 by the court for this purpose. Previous to the development of wire drawing, wire was made by hammering or beating metal into thin sheets or plates, which were cut into continuous strips. These strips were then afterwards rounded by hammering.

MODERN WIRE DRAWING MACHINES.

The machines illustrated in connection with the present article, and the methods described, are those used by a company which manufactures high-class wire, mainly for electrical purposes, the wire being drawn from nickel-steel and nickel-chromium alloys, copper and nickel alloys, copper and brass. The methods employed for drawing wire of different materials must be varied to suit the metal or alloy being drawn, and, therefore, a number of different types of wire drawing machines are employed. The diameter to which the wire is drawn also has an influence on the choice of methods used. The special qualities required of the wire used for electrical instrument work, especially electrical heating devices, pyrometers, etc., are that it shall have a high resistance and a high melting point. This is the reason for the use of the many special alloys mentioned.

In describing the methods used, three main divisions or classes of wire may be distinguished, and the special machines and methods used for each class will be illustrated and described. The first class comprises iron and nickel, and nickel and copper alloy wire drawn to a diameter of from No. 3 to No. 18 Brown & Sharpe wire gage (from 0.229 to 0.040 inch in diameter). The second class comprises wire of the same materials from No. 18 Brown & Sharpe gage (0.040 inch) down to 0.002 inch in diameter. The third class comprises brass and copper wire in sizes from ¼ inch in diameter down. In addition, flat wire is manufactured. This is first drawn round, however, to a given diameter, and is then merely flattened out between ground rollers.

*Reproduced from *Machinery*.

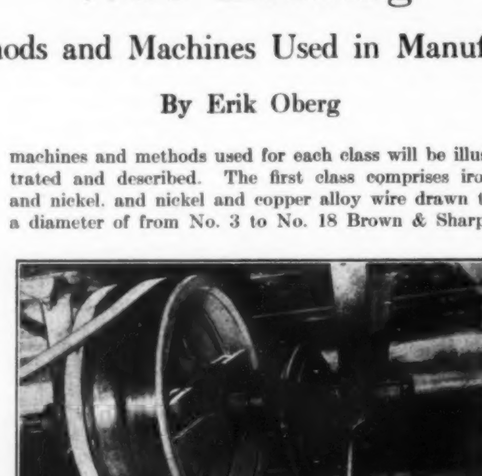


Fig. 4.—A Wire Pointing Machine.

DRAWN WIRE MADE FROM NICKEL STEEL, NICKEL CHROMIUM, AND NICKEL AND COPPER ALLOYS.

The wire from which the finer sizes are drawn is about ¼ inch in diameter. It is rolled to this dimension in the wire rolling mill connected with the wire drawing mill, and is wound up into coils suitable to be put onto the reels used in connection with the wire drawing machines. In the rolling mill department the various alloys are melted, cast into ingots, hammered and rolled out, in much the same way as is ordinary drill-rod or tool-steel wire.

After having been received from the rolling mill, wire of the size and material constituting the first class mentioned in the foregoing, is drawn in wire benches or machines of the type shown in Fig. 1. Before the drawing commences, the wire must be pointed so that the operator can push the end of it through the draw plate, this plate being provided with holes through which the wire is pulled in order to reduce its diameter. The pointing is done in the machine shown in Fig. 4, which is provided with two rollers, oscillated back and forth by means of the lever shown on the right-hand side of the machine, and the eccentric mounted on the countershaft near the ceiling. The rollers are provided with a number of grooves in their faces, the grooves of the two rollers meshing with each other and the diameters of the grooves decreasing successively from one end of the roller to the other. The upper roller can be raised and lowered by manipulating a handle at *A*. By pushing the wire into a number of successive grooves, the operator obtains a point for starting it through the draw plate.

Referring to Fig. 1, the wire is pushed by hand through the hole in the draw plate *A*, which is of the correct diameter to which the wire is to be reduced. It is then pulled through by power for a distance of about 24 to 30 inches by means of an arm *B* provided with a tong or grip jaws at its end, and operated by a cam on the vertical shaft of the machine upon which pulley *C* is mounted. As soon as a sufficient portion of the wire has thus been pulled through to permit it to be attached to the pulley or block upon which the drawn wire is wound, the end of the wire is clamped between jaws *D*, as shown, and the block is set in motion by a foot treadle, which permits it to engage a clutch, thus connecting it to the driving mechanism beneath the wire bench. This driving mechanism consists of a longitudinal shaft which drives a number of blocks by means of spur and bevel gearing.

The blocks are driven at different speeds according

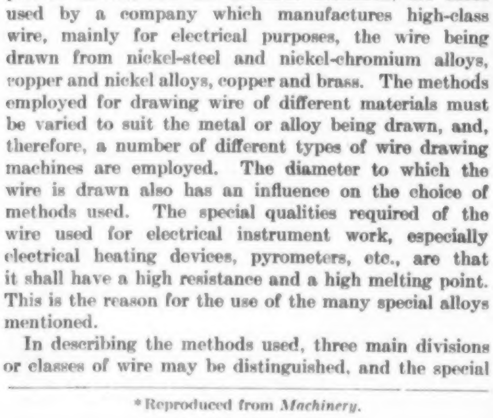


Fig. 5.—Part of a Continuous Wire Drawing Machine for Finer Sizes of Wire.

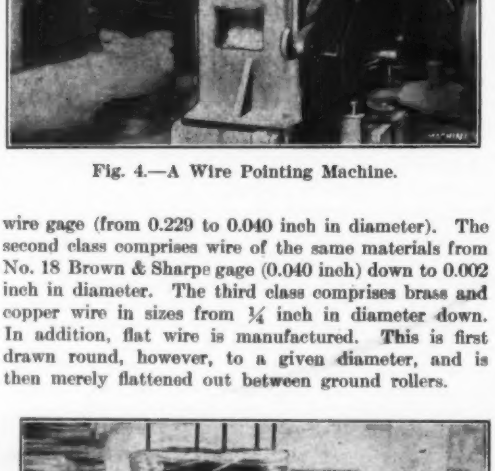


Fig. 6.—Another Type of Wire Drawing Machine Used for Copper and Brass Wire.

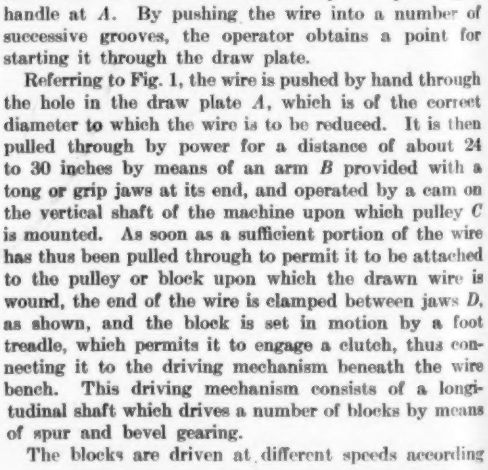


Fig. 7.—A Machine Known as "Bull-block," Used for Heavy Sizes of Copper and Brass Wire.

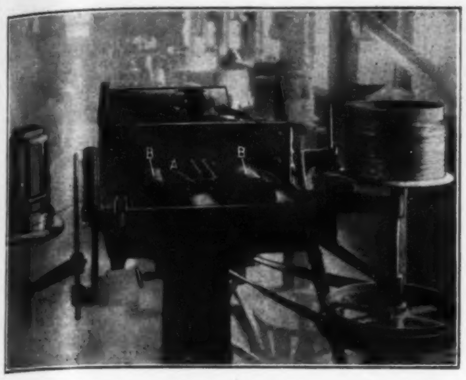


Fig. 8.—Another Continuous Wire Drawing Machine for Fine Wire.

to the diameter of the wire being drawn and the characteristics of the alloys used. A general idea of the speeds allowable may be had from the fact that iron and brass may be drawn at velocities varying from 12 to 45 inches per second. Wire of less tensile strength must, of course, be drawn at a slower speed than that of a higher tensile strength. On the other hand, more ductile wire can be drawn at a much higher speed than that which is less ductile. One of the important considerations in wire drawing is that a line passing at right angles through the center of the hole in the draw plate through which the wire is drawn, and at right angles to the face of the plate, should be tangent to the pulley or block upon which the wire is wound; otherwise, the wire is liable to become kinky and will not be of a uniform structure throughout its cross-section.

When drawing, the wire is pulled off from a reel on which the coil is laid previous to drawing, and is reeled off as the drawing proceeds. These reels are not shown in Fig. 1, but one of them can be seen to the left in Fig. 8. Before the wire goes through the draw plate, it passes through a container holding the lubricant. Grease, soap water or pulverized soap are used for lubricating the wire, according to the material being drawn. Music wire, the characteristic of which is that it possesses exceedingly high tensile strength, must be drawn wet or very thoroughly lubricated, and, in this case, the reels with the wire are set into tubs containing the lubricating solution of soap water and are reeled off from the submerged reels and immediately drawn through the draw plate. At first thought it might seem that the same result would be obtained by flooding the wire in soap solution immediately before it enters into the hole in the die. Undoubtedly the same effect would be obtained in this manner, but the method of submerging the coils in a tub containing the lubricating solution has been found simpler, as in this wa pumping arrangements, piping and pans for taking care of the lubrication become unnecessary.

The draw plates, three of which are shown in Fig. 2, are made of a high-grade tungsten steel into which usually eighteen holes of different sizes are drilled and reamed. These holes taper, having the correct diameter of the wire to be drawn at that face of the plate which is toward the block or pulley. The draw plate in the center shows the face, while those at the sides show the back of the plate with the tapered hole where the wire enters. The draw plates are furnished already drilled and reamed by the steel makers, and the only work required to be done on these plates in the wire drawing mill is to keep the holes to size. This is done by heating the plates and hammering them so as to reduce the diameter of the holes. After the plates have been hammered the holes are reamed out by small hand reamers, the size being gaged by drawing a wire through the hole and measuring it by micrometers. The diameter of the wire drawn is also measured by

Fig. 9.—A Collection of Diamond Dies.

micrometers after each time it has been passed through the draw plates, in order to guard against inaccuracies due to the wear of the holes in the plates. These holes wear very rapidly, and it is, therefore, necessary to keep constant watch as to their performance.

The wire is reduced in diameter at each drawing or pass by one number or step in the Brown & Sharpe wire gage scale. This wire gage, which was compiled in 1864 by Messrs. Brown & Sharpe, is not entirely arbitrary, as one might think after a casual inspection of the wire diameters of the various sizes, but the diameters of the wires of successive numbers increase according to a geometrical ratio. For example, the step between Nos. 17 and 18 Brown & Sharpe gage is about 0.005 inch, while the step between Nos. 8 and 9 is about 0.014 inch. The ratio of the diameter of No. 8 to No. 9 is the same, however, as the ratio of No. 17 to No. 18. Each succeeding number can be found by multiplying the preceding number by 1.123, this being the constant factor of the geometrical ratio on which the Brown & Sharpe wire gage system is based.

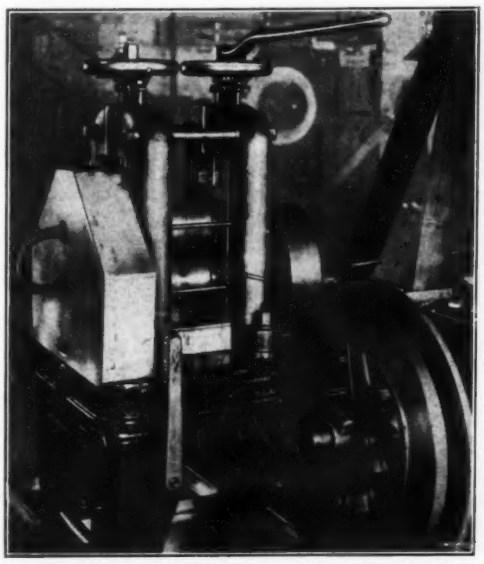


Fig. 11.—Machine for Rolling Flat Wire.

The basic size is No. 36 wire, which is 0.005 inch in diameter.

The drawn wire wound up on the block of the wire drawing machine requires to be annealed either between each pass, as in the case of certain materials, or between, perhaps, only every fifth or sixth pass, as in the case of other alloys. For the annealing process the wire is packed in large cast-iron pots about three feet in diameter and six feet high, some of these pots being shown in Fig. 3. Four furnaces are provided, each capable of holding one of these pots, the pots being lowered down into the furnace in a vertical direction. The temperature of the furnace is gaged by means of pyrometers. The pots containing the wire coils are heated for about ten hours and are then permitted to cool for about twenty-four hours. According to the

Fig. 10.—Annealing Furnace for Copper Wire.

material being annealed, the wire is either put in the pots without any packing at all, or, in other cases, packing of charcoal, sand or lime is used. After the annealing pots have cooled off and the wire coils have been taken out of them the coils are pickled by being dipped in tanks containing diluted sulphuric or hydrochloric acid. This acid is then dried off by drying the wire coils in an oven heated by means of steam coils to a temperature of about 220 deg. Fahr.

DRAWING FINE SIZES OF WIRE.

The finer sizes of iron, nickel and chromium alloy wire, those between 0.040 and 0.002 inch in diameter, are drawn through a succession of dies at one operation. These finer sizes are pointed either by merely pulling the wire apart by hand or by filing the end. Part of one of the machines used for drawing wire down to 0.010 inch in diameter is shown in Fig. 5. The wire is reeled off from a reel at the left, which is not shown in the illustration, and then passes successively through the dies shown at *A*. After the wire has passed through one die it passes around a pulley *B*, mounted on a vertical shaft, and then through the next die, and so on until it has gone through the required number of successive dies. The maximum number of dies provided in this machine is ten, of which only five are shown. To the right is shown the block or drum upon which the drawn wire is coiled.

Each die reduces the diameter of the wire one number in the Brown & Sharpe wire gage scale. The various pulleys *B* are geared to the proper speed for the diameter and speed of the wire at the time it passes around each respective pulley. It is evident that as the wire travels hrough die after die and is gradually reduced in diameter, the speed at which the wire passes around the pulleys and through the next die increases. As the Brown & Sharpe gage numbers decrease according to a geometrical ratio, the speeds of the pulleys are also in a geometrical ratio, increasing with the decreasing diameter of the wire. In designing the machine, it is assumed to be preferable to have the pulleys run a trifle too slow rather than too fast, in order to prevent the wire from coiling up in front of the die it is to pass through. If the speed is a trifle too slow there will be merely a pull on the wire which, within limits, has no detrimental effect. The rollers and dies are all immersed in a soap solution for which the machine bed itself forms a trough, as shown, so that the wire is thoroughly lubricated while being drawn.

Sizes finer than 0.010 inch are drawn in machines of the type shown in Fig. 8. In these machines the dies are all placed in the central bracket *A*. while the wire is wound back and forth over drums *B*. The reel from which the wire is being wound off is shown at the left, and the block on which it is wound after having passed from the last drawing die is shown to the right. Block *A* contains twelve dies, and the drums *B* are grooved so that the wire is wound around them from the back toward the front, passing through a die each time it

Fig. 12.—Flat Wire Slitting Machine.

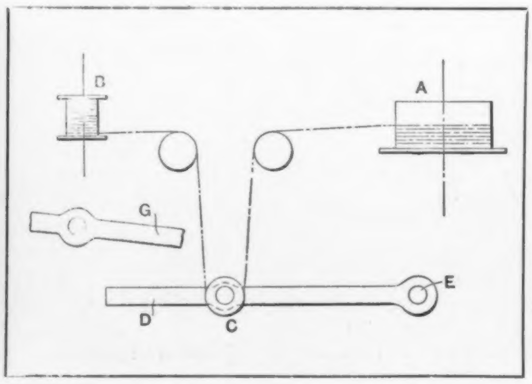


Fig. 13.—Diagrammatical Sketch of an Ingenious Safety Trip.

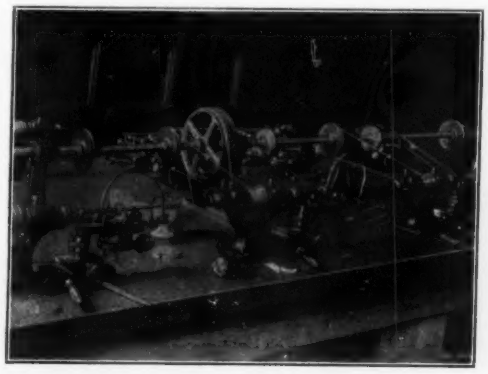


Fig. 14.—Some of the Diamond Die Drilling Machines.

passes on the upper side from the left to the right drum. In this case the wire is reduced, for each pass, only one half of a number in the Brown & Sharpe wire gage scale. As the wire between the various passes runs over drums rotating at a uniform speed, the increase in speed of the wire as it is reduced in diameter must be taken care of by the slipping of the wire over the drums. At first sight it might seem that this would cause difficulties, but practical experience shows that this method is perfectly feasible. The drums and the dies are immersed in soap solution the same as in the case of the machine shown in Fig. 5. While twelve dies are provided in this case, it is evident, of course, that when the reduction to be made is less than that for which all the twelve dies would be required, only the number of dies that corresponds to the required reduction is used. After the wire has been drawn, it is annealed as already mentioned in the case of wire of larger diameter.

DIAMOND DIES.

The dies used for the drawing of the finer wire are so-called diamond dies, a number of these being shown in Fig. 8. These dies consist of a body made from brass into which is counterbored a hole of about ½-inch diameter. A small hole for the wire is drilled clear through the brass body. The counterbored hole in the body constitutes a seat for the diamond which is set in the center of the hole with molten brass or solder poured in around it until the hole is filled.

A view of the diamond die drilling department is shown in Fig. 14. The machines shown in the foreground are for recutting or enlarging the holes in dies which are worn, while the machines in the background are used for cutting or drilling the holes in new diamonds.

When a diamond die is to be made, the diamond (of the variety known as bort) is first prepared in a regular bench lathe. The diamond or "stone," as it is ordinarily termed in the shop, is held to a small faceplate in the bench lathe by diamond cement. It is then flattened on two sides by means of another stone held in a pair of pliers. The stone is then cupped or centered (also by the use of another stone) to provide a starting point for the diamond drill, by means of which a fine hole is drilled with the drilling machine shown in the background of Fig. 14. The stone is held in this machine on the flat end of the spindle with diamond cement. The drill used for the hole is made from an ordinary sewing needle ground on the end by hand to the correct diameter. This needle, the end of which is supplied with diamond dust and oil, is put into a rotating spindle in the machine and revolves at a speed of about 2,000 revolutions per minute. The stone itself does not revolve, but merely oscillates back and forth toward the needle, the oscillation being produced by a cam. Provisions are made for increasing or decreasing these oscillations, and for feeding the stone forward toward the needle as the hole is being drilled through. Ordinarily, about ten hours is required for piercing an average stone. The hole in the stone is gaged by drawing a wire through it and measuring the wire with a special micrometer, graduated so as to read directly to 0.0001 inch, and on which it is easy to estimate one half of a ten thousandth of an inch on account of the size of the graduations.

After the hole has been drilled through to the proper diameter it must be tapered at the back end, much the same as the holes in the large draw blocks in Fig. 3 are tapered. The taper in the stones is produced by grinding the needle to a taper and using the same machine with diamond dust and oil as before. After the stone has been drilled, tapered and properly gaged, it is placed in the holder. While pouring the molten brass into the counterbored hole in the holder the stone is held in place with a center in a small machine similar to a bench drill press.

After having thus secured the stone in the die, the die-holder is faced off in a bench lathe, and the proper setting of the diamond in the die is tested by placing the die on a needle of the correct diameter for the hole in the diamond. If the die "balances" perfectly on the needle it indicates that the diamond is properly set into the body. It is important that a die be set with its axis accurately at right angles to the face of the brass disk or body, as otherwise the wire drawn through it will not be straight. Should the die show a tendency to stand off at an angle when pushed onto the testing needle, this would indicate that the hole in the diamond was not set squarely with the face of the die. To the observer, the method of making a diamond die is apparently simple, but it requires a great deal of skill and patience.

A record is kept of the performance of all dies, showing the material on which they are used and the length of time that the hole remains true to size. When the dies are found to be worn they are sent back to the diemaker, who first tests them for size and examines them under a microscope to determine the condition of the die. Sometimes the dies crack after having been used for some time, in which case they are either used for smaller dies or are crushed to provide the diamond dust by the aid of which the holes in the dies are drilled and enlarged. Those dies which upon their return are found to be perfect, except that they have worn so that they cannot be used for the size to which they were originally cut, are enlarged so as to be used for the next larger size of wire.

The recutting is done in the recutting lathes shown in the foreground in Fig. 14. In this case the die is held with wax onto the faceplate of the spindle of the machine and is revolved at about 1,800 revolutions per minute. The needle which enlarges the hole is not revolved in this case, but is oscillated in the longitudinal direction by a cam and by the spring shown bent over the tailstock end of the machine. The stones vary in hardness, and while the average time for enlarging a hole 0.001 inch in diameter is about one and one half hours, in many cases it happens that ten or twelve hours is required for removing a single thousandth of an inch. In this department there are thirteen recutting lathes and three machines for cutting new diamond dies constantly in operation, and the diemaker must keep a careful record of the conditions under which each machine operates, so that he can stop a machine and test his die at the right time. The machines are all driven from a shaft running through the center of the table, as shown, this shaft being driven from a motor underneath the bench.

BRASS AND COPPER WIRE.

Brass and copper wire is drawn more easily than are the larger sizes of alloy wire, and can, therefore, be drawn, for all sizes, in machines having a number of successive dies. The machine shown in Fig. 7 is called a "bull block," and is used for drawing brass and copper wire in sizes between ⅛ and ¼-inch in diameter. This machine has a capacity for seven dies, although, of course, the number of dies being used at any one time is determined by the required reduction of the wire. In the illustration five dies are used. Each pass reduces the wire one number on the Brown & Sharpe wire gage scale. The reel on which the coil of wire being drawn is held, is shown to the left, and at the extreme right is shown the block onto which the drawn wire is wound. The last die at *A* revolves about the wire being drawn in order to produce a smoother surface. The dies proper are made of rectangular blocks of chilled cast iron. The wire passes through the dies and around the pulleys shown between each pair of dies in a manner similar to that described for the machine shown in Fig. 5. The lower half of the pulley is immersed in lubricating solution, the bed of the machine forming a trough for this. The wire is threaded through the various dies by a special machine by means of which it is pulled through each die an amount sufficient to wind it around the pulleys once or twice before starting the operation.

Another machine used for drawing copper wire is shown in Fig. 6. This machine is constructed somewhat on the same principle as that shown in Fig. 8, except that the drums over which the wire passes between each pass through the dies are not cylindrical, but conical in shape. This takes care of the increasing velocity with which the wire travels as it is reduced in diameter. It passes over the smallest diameter pulley when it is large in diameter and successively mounts the higher steps as it is reduced in size, until it finally is wound onto the block or drum shown in the background.

An interesting method is used for annealing brass and copper wire. The heat for annealing this wire need not be as high as that for annealing the alloy wire, and, hence, a different furnace is used. This furnace is shown in Fig. 10, the furnace proper being shown towards the right, it having an extension in the right-hand direction similar to that shown on the left-hand end in the illustration. The coils of wire are placed on an endless chain which moves from the left to the right. This chain is shown in the illustration passing over rollers at the extreme left-hand end. The furnace proper is in the center and the extensions at the ends are tanks filled with water which serves as a water seal, preventing the air from entering the furnace, thus avoiding oxidation and insuring uniformity in temperature.

The furnace is fired with soft coal, but the gases of combustion do not come into contact with the material being annealed. The endless chain moves slowly, carrying the coils down through the water tanks and up into the furnace, the speed of the chain being so timed that the coils remain in the furnace for a certain length of time to heat them to the required temperature. The speed of the chain can be regulated so that the coils of wire will remain from one to five hours in the furnace. The coils pass out of the furnace at the right-hand side through a water tank similar to that shown at the left-hand end and are removed as they reach the right-hand end.

MAKING FLAT WIRE.

The flat wire, as already mentioned, is produced from drawn, round wire of the required diameter. One of the machines used for flattening the wire is shown in Fig. 11. The machine consists principally of two hardened steel rollers, the upper one of which is adjustable for height. These rollers are carefully ground, and as the round wire is passed between them it is gradually flattened out to the required thickness in a series of successive passes between the rollers. The rollers must be very hard and are not tempered after hardening. They are imported, being made of a special alloy steel, and the cost of a pair of these rollers may be as high as $300 or $400. It is highly important that they be of uniform hardness throughout, as otherwise they would wear more on one side than on the other and produce a wire which would not be uniform in thickness.

The diameter of the round wire to be used for a given size of flat wire is determined by experiments, and these experiments must be repeated for wires of different materials, as some materials cannot be successfully flattened to the same degree as others. On the side of the machine from which the wire passes in between the rollers there is a clamping device which provides the proper tension for the wire, so that it is fed in under tension. On the side where the wire passes out from between the rollers, as shown in the illustration, a large wheel is placed, onto which the flat wire is wound up as it comes from the machine.

When very wide, flat wire is to be made, uniformity of width cannot be obtained by a mere rolling process, but it is necessary to slit or trim off the sides of the wire to a uniform width after rolling. Should an attempt be made to flatten the wire, say in a grooved roller, so as to insure thickness and width at the same time, the rollers for this purpose would be so expensive that the method would not be commercially useful. Slitting machines, such as shown in Fig. 12, are, therefore, used for cutting the wire to a uniform width. These machines consist mainly of three steel disks, two on the lower shaft and one on the upper. The upper disk trims the wire between the two lower disks. Very wide, flat wire can be slit into several uniform widths at a time, if required. The sizes of flat wire that can be rolled in the manner described vary from 2½ inches wide by 0.020 inch thick down to 1/64 inch wide by 0.002 inch thick. Flat wire 1 inch wide can be rolled as thin as 0.003 inch thick by this method.

When the wire is slit, the band of flat wire that has been cut to the correct width is wound up on a block or drum, as shown at *A* in Fig. 12. It is also necessary, however, to take care of the scrap cut off, as otherwise this would be likely to cause trouble. The scrap wire is, therefore, wound up on the lower drum shown at *B*, these drums being geared to the proper speed so as to wind up the material as fast as it comes from the machine.

After the wire has been rolled and annealed, it is wound onto spools of the required size for the market. Some wire is spun over with insulating material and some braided, according to the requirements for which it is to be used. A diagrammatical sketch of an interesting feature of one of the spooling machines, which may be worthy of mention, is shown in Fig. 13. In this *A* represents the reel on which the wire coil is put, while *B* is the spool on which it is wound. This spool is driven at a constant speed. Now, if a kink should occur in the coil of wire at *A*, or, for some other reason, it should be prevented from reeling off easily, the wire would, if it passed directly from the reel to the spool, either be pulled off, or some damage would be done to the machine. In order to prevent this, the wire is passed over an idler pulley at *C*, which is mounted on a lever *D* moving about a fulcrum *E*. When the spooling is proceeding under normal conditions the weight of the lever is great enough to prevent the pull on the wire from lifting the lever, but should an abnormal resistance be placed on the wire, as mentioned, the lever will strike another lever or trip *G*, which will throw out the clutch driving the spool and, hence, stop the machine.

The Vibration of Rifle Barrels.*

By Francis Carnegie, Assoc. M. Inst. C. E.

THIS paper is a record of practical investigations into the effect of vibrations on rifle barrels, and furnishes conclusions which are of service in the design and manufacture of rifles. A rifle barrel is very sensitive to transverse stress, and vibrations are produced in it chiefly as a result of the explosion of the charge, and also in consequence of the friction between the bullet and the barrel, and the reaction between the bullet and the rifling. These vibrations cannot be detected by the eye, and are studied by means of instantaneous photography. A brief *résumé* is given of experiments carried out by earlier investigators on this subject, together with a description of the apparatus employed

*Abstract of a paper read at the ordinary meeting of the Institution of Civil Engineers and published in the *English Mechanic and World of Science*.

and the conclusions arrived at. The first experiments recorded are those of Drs. Crehore and Squier, who assert that the barrel does not move appreciably before the bullet leaves the muzzle, and that even if the motion were appreciable, the aim of the rifle would not be affected. Experiments were also undertaken by Major Close, R.E., who, however, arrived at an entirely different opinion. The conflicting results of these experimenters led Profs. Cranz and Kock, of Stuttgart, to investigate the subject. The apparatus they employed for obtaining the vibration photographs was far more accurate and reliable than those used by either Drs. Crehore and Squier, or Major Close, and after elaborate experiments on large- and small-bore rifles their results confirmed those of Major Close. In addition, the German investigators found that the vibrations of a barrel were very similar to those of a rod clamped at one end: that the barrel vibrates to a fundamental note, and to an overtone; and that the departure of the bullet is principally determined by the overtone vibrations. Lieut. Thompson, R.E., working on the same lines as Major Close, also confirmed the results of the latter. In addition, he found "that the projection of the path of a vibratory point near the muzzle on a plane perpendicular to the axis of the barrel may be considered to be an elongated ellipse whose major axis is vertical." The field of investigation covered by the author's experiments includes the following:

1. To find if the vibrations of a 0.303-inch Mark III. Lee Enfield rifle varied when different methods of "stocking-up" were employed.

2. To find if the external shape of the barrel had any influence upon the vibrations.

3. To find if the twist of the rifling affected the vibrations.

4. To find if the ease or tightness with which the barrel and body (or receiver) were screwed together influence the vibrations.

5. (a) To find if a cartridge from a definite batch of ammunition produces vibrations corresponding with those obtained from another cartridge taken from the same batch: (1) In the same rifle; (2) in other rifles of the same type. (b) To find if an alteration in the muzzle velocity affected the vibrations, other conditions remaining constant.

As vibrations in the horizontal plane are practically negligible, the author confines his experiments to vibrations in the vertical plane only. The apparatus employed was a modification of Profs. Cranz and Kock's, and tests made for possible sources of error therein were shown to be non-existent by the photographs obtained. The position of the nodes from the free end of the barrel, and the number vibrations per second corresponding with the various overtones are calculated. Each series of experiments is then discussed separately in detail, with reference to the photographs, as follows:

1. Ammunition of 2,000 foot-seconds normal velocity is used, and the natural vibration of the barrel is first taken by removing all its attachments. These attachments are then added one after the other until the rifle is fully "stocked-up," photographs being taken after each addition to show how the vibration of the rifle is affected. Arising out of these results the position on the vibration-curve at which the bullet leaves the muzzle is discussed, and the author favors the point of maximum displacement, as a much less scattered group is likely to be obtained on the target.

Inner bands which tie the barrel to the fore-end were next used at the nodes in varying combinations, and their effect on the vibration was observed by means of the photographs. Uniformity of results points to the conclusion that in any system of nodal clamping with inner bands, as usually fitted, the vibrations of the barrel are practically the same, assuming other conditions remain unaffected.

2. Three different designs of barrels were used, and an examination of the photographs shows that the exterior shape of the barrel materially affected the vibrations. Shooting trials discovered that considerable metallic fouling lodges in the barrel where a change in the exterior diameter takes place.

3. Barrels with twists ranging from one turn in 6 inches to one turn in 15 inches by increments of 1 inch were used. The photographs indicate that the vibrations of the barrels are altered to a marked degree by a variation in the twist of the rifling; but the results do not establish definite conclusions as to the exact relation between the vibration and twist. Tables of velocities and pressure obtained from these barrels do not help to elucidate the point.

4. Three natures of breeching-up of barrel and body were adopted: Abnormally tight fit, normal fit, and loose fit. The results show a considerable difference in the vibrations, and if regular and consistent shooting is to be maintained, correct breeching-up must be enforced.

5. Ammunition with velocities ranging from 2,000 to 2,600 foot-seconds was used, and the point of impact, taken on a target distant 15 feet from the muzzle, is indicated on the photographs.

Cartridges from a definite batch of ammunition fired in the same rifle produced similar vibrations, and where similar well-defined vibrations exist, similar points of impact are to be expected. In other rifles of the same type, similar cartridges do not produce exactly similar vibrations, due apparently to the personal element entering into the "stocking-up" of the rifle. An alteration in the muzzle velocity of the ammunition manifests but little difference in the general characteristic of the vibration-curve for any given rifle. However, the higher-velocity bullet leaves the muzzle of the barrel at an earlier period on the vibration curve, and if the point of exit of bullet is lower on the curve, the point of impact is lower on the target.

Marconi Multiple Syntonizer

The instrument known as the syntonizer is designed in the first place to facilitate the tuning of radiotelegraph stations; it can, however, also be used to determine the length of the waves and to estimate approximately the distance between two stations.

The Marconi "Multiple Syntonizer," constructed with a view to these two purposes in particular, comprises the following elements: In the antenna circuit, an adjustable inductance and capacity; in the receiving circuit, which is by preference a magnetic detector with a two-centimeter coil, an adjustable capacity; for coupling the two members of the installation, a system of two induction coils, the primary windings of which are coupled, the one with the antenna circuit and the other with the detector circuit, while the two similar secondaries have their terminals connected to a third capacity, as shown in the diagram.

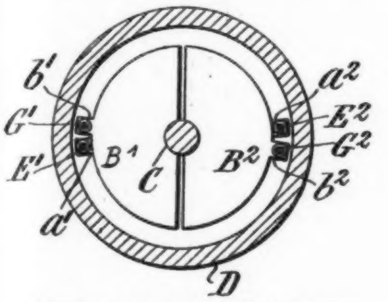


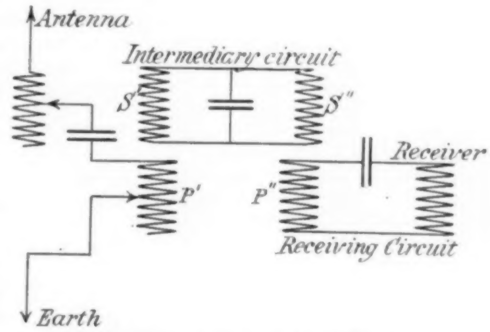
Diagram of the Adjustable Condenser.

The adjustable condensers used in the construction of the apparatus are the usual disk type commonly employed at the present day in this kind of work, and known as the Marconi adjustable condensers. The disk condenser consists of two groups of semi-circular metal plates inclosed in a box and separated by insulating disks. The plates have a central perforation through which passes an insulating axis, and are provided with projections *a*, *b* placed diametrically opposite each other; all those of one group *B* are threaded upon two rods *G* which pass through the bottom of the box and serve the double purpose of holding the disks in place and connecting them electrically with one another; the disks of the other group are similarly threaded upon two rods *E* which pass through the lid of the box; by rotating the latter all the plates of one set are thus simultaneously moved in relation to the other, the fixed set, and the capacity of the condenser is thus regulated between a certain minimum and the maximum, which depends on the dimension and the number of the disks. The maximum in the apparatus ordinarily employed is 100th of a micro-farard.

In addition to these features there is a spark micrometer, an induction coil connected between the terminals of the antenna circuit, a cut-out and a syntonizing switch for altering the grouping of the condensers. The whole apparatus is contained within a wooden box measuring 21 inches by 9 inches by 11 inches, and weighing 32 pounds. The spark gap is situated outside the box, over which rise the milled heads for adjusting the inductances and capacities. The three capacities are adjustable, and the primary and secondary windings of the induction coils can be moved with regard to one another.

External View of the Marconi Syntonizer.

The instrument is not permanently connected to the antenna, but is detached therefrom during transmission by opening a switch provided for this purpose. Still the antenna can be placed in circuit through the secondary of the jigger, in which case, however, a telephonic short-circuiting key must be introduced.



Sketch of the Electric Connections.

In order to use the apparatus the change switch is placed in the position corresponding to the direct connection of the detector with the condenser of the antenna. Thus set the device responds to all signals.

If the station with which it is desired to enter into conversation is recognized, the inductance of the antenna circuit is then adjusted so as to obtain the maximum intensity, the syntonizing switch is placed in the position corresponding best to the wave length indicated by the antenna circuit; the change switch is placed in the syntonizing position; then the condensers, both of the intermediary circuit and of the receiving circuit, are regulated until the maximum effect is secured. Adjustment is finally completed by manipulating the antenna circuit and then coming back to the intermediary and detector circuits.

The relative position of the coils is controlled by means of a literal handle; the more this handle is turned the looser is the coupling and the more exact the tuning obtained. It may be taken that the indications of the instrument are sufficiently exact for practical purposes when the handle is turned to 80 degrees. From the position of the handle it is possible to deduce, by means of a table the wave length to which the instrument is tuned.

When once the apparatus is adjusted the angle through which the handle can be turned measures the intensity of the signals received, and may by comparison give some idea of the distance from the transmitting station.

Photographs by R. C. Osburn.

The Crayfish in His Typical Walking Position.
In the water the crayfish balances himself easily on the walking legs.

Normal and Pale Phases of *Cambarus limosus*.
The pale form is really much lighter than it appears in the cut, being nearly white.

The Crayfish*

One Year's Catch in the United States Valued at $34,000

By Raymond C. Osburn, Ph.D.

None of the inhabitants of fresh water are better known to the casual observer and few have been the subject of more study by naturalists and scientists than the crayfishes. These are popularly known by a variety of names such as crawfish, crawdad, cray, lobster, crab, etc. The origin of the word "crayfish" is interesting as an illustration of the changes which words sometimes undergo during the evolution of languages. Apparently from the Old High German word "Krebis" there have been derived the modern German word "Krebs," the Old French "crevice" from which has come the modern French "ecrevisse," and the Old English "crevis" or "creves," which has been corrupted into "crayfish" and still further into "crawfish."

Every country lad knows where and how crayfishes may be found, and is quite familiar with their propensity for stealing bait when he is fishing for the far more desirable suckers, catfish and shiners; and what barefooted urchin in the country does not possess among his treasures at least a few crab's-eyes or lucky-stones, as the calcareous concretions formed within the thorax are called? Though harmless enough, they are usually greatly feared by the small boys and girls who love to wade barefooted in the shallow streams and ponds. The bass fisherman fully appreciates the value of the soft-shelled stage as a tempting lure for the wily game.

Popular writers have, for the most part, overlooked the possibilities of the crayfish and references to this interesting animal outside of scientific literature are rare indeed. James Whitcomb Riley, who has been able to see something of poetic charm in many of the humble creatures of the woods and streams, evidently considers the crayfish as occupying the lowest limit of existence for he pictures a treetoad utterly disgusted with the long and continued drought, which

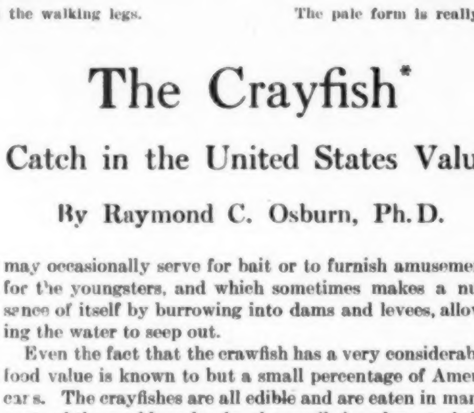
"Jest backed down in a crawfish hole
Weary at hart and sick at sole."

Alfred Henry Lewis's "Crawfish Jim," though harmless, is not a particularly attractive character. Even the English language takes a fling at the little crustacean on account of his mode of backing out of difficulties, and "crawfishing" is widely and slightingly applied to this method of the human species in escaping from an unpleasant situation.

Various scientific monographs have been written on the structure, habits, distribution and relationship of the crayfishes, while their use as a laboratory type for the purpose of illustrating the crustacea has become a matter of course in the colleges and secondary schools of Europe and America. Yet in spite of all that has been written by the scientists, the natural history of the crayfish is but little known to the general reader, and it is commonly regarded as a useless and uninteresting animal, which may occasionally serve for bait or to furnish amusement for the youngsters, and which sometimes makes a nuisance of itself by burrowing into dams and levees, allowing the water to seep out.

Even the fact that the crawfish has a very considerable food value is known to but a small percentage of Americans. The crayfishes are all edible and are eaten in many parts of the world, and only the small size of most of the species has prevented them from being any less popular than the lobster as an article of diet. The large muscles of the abdomen, similar to those of the lobster, are the most valuable parts. Many a country boy has discovered that a luscious tidbit may be obtained by removing the big muscle and toasting it on a stick before his campfire. In Europe they are commonly used, and in some places are cultivated for market.

The special report on the fisheries of the United States contained in the last report of the Bureau of the Census, states that in the year 1908 the total catch of crayfish in this country was 666,000 pounds, netting the fisherman $34,000—a little over five cents a pound. The States chiefly interested in this industry at that time were Louisiana, 88,000 pounds; Oregon, 178,000 pounds, and



A Female Crayfish.
Showing method of carrying the eggs.
Photograph by R. C. Osburn.

Wisconsin, 348,000 pounds. But the Oregon crayfish (of the genus *Astacus*) are larger than the eastern species (of the genus *Cambarus*) and so command a higher price. Perhaps the absence of lobsters from the Pacific coast may have been a contributing factor, but at any rate the Oregon catch was valued at $14,000, while the Wisconsin catch, though nearly twice as large, was valued at the same figure. While crayfishes may be taken by lines, nets and seines, the chief method of capture is the trap or pot, and, according to the census estimate, 606,000 pounds of the total were taken in this manner. In New York city the demand for crayfishes is confined almost entirely to the foreign population, who have learned abroad to appreciate the delicacy of this aquatic food. Yet a very considerable quantity is consumed here, and shipments are received from numerous sources. Dr. E. A. Andrews[1] is responsible for the statement that one half million crayfishes are shipped to New York annually from a very limited region on the Potomac River.

The crayfishes belong to the decapod, or ten-footed crustacea, and are thus closely related to the marine lobster and prawn. They constitute a separate family, the *Astacidæ*, which is represented in every continent (Africa excepted) and in many of the larger islands of the world. This family is divided into two sub-families: the *Astacinae* and the *Parastacinae*, limited respectively to the northern and southern hemispheres, with the exception that the genus *Parastacus* of South America ranges northward into Mexico. For some unknown reason, the crayfishes have been unable to adapt themselves well to the conditions of life in the tropics, and but few species are found outside of the temperate zones. Quite a number occur in Mexico, especially in the highlands where temperate conditions obtain.

The *Astacinae* contain three genera whose distribution is very interesting and the reasons for which are not fully understood. The species of *Astacus* occupy Europe and western Asia and the Pacific slope of North America, while the genus *Cambarus* is limited to North America east of the Rocky Mountains, and the closely related *Cambaroides* to eastern Asia. Thus each group, *Astacus*, and *Cambarus* plus *Cambaroides*, is divided into two widely separated fields, between which occurs a division of the other group. There is no overlapping of the groups to indicate that they have occupied the same region at the same time. The absence of crayfish from Africa is especially interesting in view of the fact that they occur in Madagascar. This, however, is in accord with the distribution of certain Madagascar animals, for example, the true lemurs, which flourish on this and other islands of the Indian Ocean, but not on the mainland.

The first important work on the North American crayfishes was that of Hagen[2] in 1871. Since that time Faxon and Ortmann have added greatly to our knowledge of the group. Hay[3] lists eighty-four species, only five of which belong to the genus *Astacus*, found west of the Rocky Mountains. The remaining seventy-nine belong to *Cambarus*, found east of the Rockies. Nine species, plus three varieties, were listed for Mexico, Central America and the West Indies. More recently several additional species have been described.

* Reproduced from its *Bulletin* by special permission of the New York Zoological Society.

1 "The Future of the Crayfish Industry." Science, new series, vol. XXIII, pp. 983-6.

2 Memoirs of the Museum of Comparative Zoology of Harvard College, II, No. 1.

3 Synopsis of the *Astacidæ* of North America. *American Naturalist*, December, 1899.

4 Crayfishes of Pennsylvania. Memoirs of the Carnegie Museum of Pittsburgh, vol. II, No. X, 1906.

Ortmann[4] has divided the crayfishes of North America according to their habits into three groups: I, river species; II, mountain stream species, and III, burrowing species. While no sharp distinction can be made between these groups, it is true that many species are confined entirely to larger streams and lakes, others are never found except in small cold streams and springs, while others are entirely burrowing in habit. The burrowing species are often found at considerable distance from any open water, in lowlands where they can have water the year round by digging holes, which, in extreme cases, extend to a depth of three or four feet. Some species, known as chimney builders, deposit the earth brought up in constructing the burrow in a ring of pellets around the opening, sometimes extending to a height of ten to twelve inches and a diameter of twelve to eighteen inches, though usually the piles are much smaller. According to Ortmann (l. c., p. 42) there is no evident purpose in constructing circular mounds. The crayfish simply adopts the easiest way of getting rid of the dirt removed from the burrow. Each hole contains only one individual, except during the time the young remain with the mother and also at the mating season, when a pair may occupy the same burrow. The holes are often found sealed up by pellets of earth placed at or near the mouth, and this is especially true in winter when they may remain sealed for three or four months.

Crayfishes are all more or less nocturnal in habit, though some of the species of the larger streams and ponds wander about a good deal during the day and are not at all averse to taking food in the daytime. Other species confine their activities to the night and lie hidden away under stones or in burrows the rest of the time. Four species found in the United States are blind and inhabit caves. The best known of these is *Cambarus pellucidus* (Tellkampf) of Mammoth Cave, Wyandotte Cave and other caverns of Kentucky and Indiana. The eyes of crayfishes are compound (i. e., composed of numerous facets) like those of insects and other crustaceans. The facets are arranged in a hemispherical form on the end of the movable eye-stalk, but in blind species the facets are wanting.

The crayfish can walk in any direction, backward, forward or sideways, by means of the thoracic legs, though progress by this means is slow. Especially is this true on land, where not having the buoyancy they possess in the water, they drag themselves along in a laborious fashion. In swimming the crayfish uses his abdomen after the same manner as the lobster, and a quick movement of the tail will send him darting backward through the water for some distance. When cornered he will defend himself vigorously with the large pincers, but he usually considers discretion the better part of valor, and escapes if opportunity offers. The method of swimming has two advantages: he presents his large fighting claws to his enemy while fleeing, and when cover is reached he can enter it backward without stopping to turn around and blocks pursuit with his claws. In fighting he possesses some of the qualities of the bulldog, and doesn't always know when to let go. If a stick is poked at him, he may attack it with such vigor that he can be drawn from his retreat, or even out of the water before it occurs to him that he can release his hold. The species which live on a muddy bottom would seem to have taken a lesson from the Hebrew exodus, and learned to cover their retreat by a pillar of cloud. In this case, however, the cloud consists of mud which is stirred up to such an extent by striking the tail on the bottom that their whereabouts is effectively obscured. When, after a few minutes the mud is settled, the crayfish may be seen half buried under it, his colors completely obscured by it, and his slowly moving antennæ and watchful eyes the most conspicuous parts observed.

In New England crayfishes are not common, and only one species (*C. bartonii*) has been reported. West of the Adirondacks and Catskills they become very abundant, and this is especially true of streams having their source in the Alleghenies and in the great central basin of the United States. No less than twenty-five species and varieties inhabit the Ohio River basin, which is perhaps the richest area in the world in species of crayfishes. Species are numerous in the South Atlantic and Gulf States, and also in the region of the Ozark Mountains west of the Mississippi.

In the number of individuals these regions are no less rich than in number of species. A single haul of a fine-meshed seine will often yield hundreds of them. In the writer's experience in collecting fishes in Ohio, the crayfishes were frequently so abundant as to materially impede the progress of the work. A half-bushel of crayfish would often have to be looked over and the smaller fishes separated from the clawing and snapping mass, and when recovered, were often found injured by the large pincers of their armored fellow captives.

Thus far only a single species has been reported in the region about New York city.[5] This is the widely distributed *Cambarus bartoni* (Fabricius), which occurs in eastern Canada and eastern United States south to North Carolina and west to Indiana, and which is the only species reported from New England. Recently the New York Aquarium has obtained an abundance of specimens of another species, *C. limosus* (Rafinesque), from Central Park Lakes, New York city, and Prospect Park Lake, Brooklyn. This species has not hitherto been known outside of the Delaware, Potomac and Susquehannah river drainages, except for one locality, Redbank, New Jersey, in the New York Bay drainage (see Ortmann's "Crayfishes of Pennsylvania"). Its appearance in the park lakes of New York City thus extends its range considerably. Dr. Ortmann has called my attention in a recent letter to the fact that this species has been introduced into a lake at East Hampton, Connecticut, and also that it has been naturalized, locally, in Germany. *Cambarus limosus* is essentially a lowland species of the rivers and ponds, while of *C. bartoni*, Ortmann (l. c., p. 447) says "Ecologically this species is a form of the rapid and cool waters of the uplands and mountains, living preferably in small streams and even in springs."

Cambarus limosus is now abundant in the artificial lakes of New York city. On seining trips to these lakes, made by employees of the Aquarium for the purpose of obtaining fishes, they have been taken readily, sometimes a couple of dozen or more at a haul. Whether they occur in the lowland streams of the vicinity has not been determined. Neither is it known whether their appearance here is of recent date, or whether they have merely been overlooked. At any rate, there are no records of occurrence in this vicinity, and the study of the specimens in the local museums reveals only very recent captures from these same lakes.

As to the possibility of recent distribution to the eastward from the Delaware River system, it seems that this may have been facilitated by means of the Raritan Canal. In this case their appearance in Central Park Lake would have necessitated the species distributing itself across the brackish waters of New York Bay or the lower Hudson River, and to get to Prospect Park Lake the East River would also have to be crossed. No crayfishes are found in salt water, however, and this fact would seem to be opposed to such a distribution. Experiments have been made at the New York Aquarium to test the resistance of this species to the harbor water, and it has been found that in brackish water having a specific gravity of 1.14 degrees they will live for many days. If investigation should prove that the species has distributed itself commonly in eastern New Jersey, the hypothesis that they have gained access to the park lakes through the brackish water of the lower Hudson would gain considerable support. There is a possibility that they may have been distributed accidentally among water plants, or that they have been purposely carried by some one. At any rate there is no question but that they have permanently adapted themselves to the local waters.

Our two local species of crayfishes may be readily distinguished as follows: *Cambarus limosus* has a strong spine on either side of the rostrum, or pointed projection between the eyes, while *C. bartoni* has no marginal spine on the rostrum. In *C. limosus* there is a patch of spines on either side of the carapace in the region of the cervical, or neck, groove, while in *C. bartoni* this region is only slightly granulated. There are various other well-marked differences in structure, form and color of the body, and especially in the appendages.

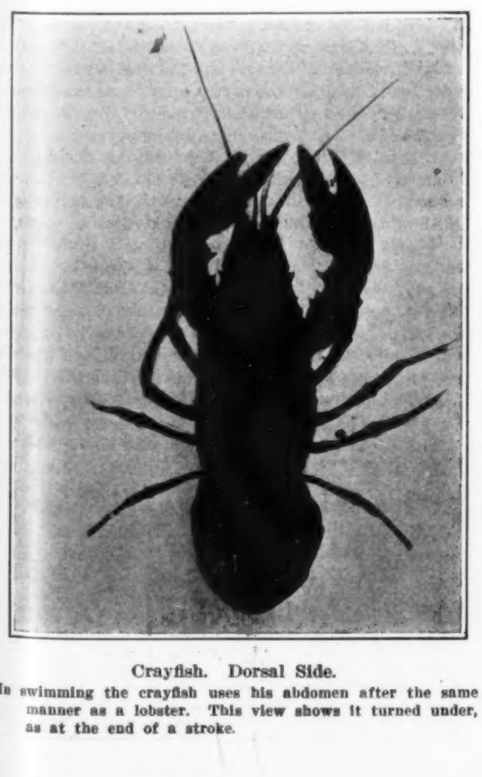
A distinct color variation not hitherto noticed in the species has appeared in *C. limosus* from this vicinity. Faxon[6] and Ortmann (*l. c.*, pp. 355-6) have carefully described the colors as usually found, which briefly stated are: Chief color olivaceous with large blotches of dark green; under parts pale. Each segment of the abdomen is marked above by paired brown (burnt sienna) spots and there is a brown spot on each side below the eye. The tips of the big pincers are ferruginous and behind this is a ring of dark green or nearly black.

The color variety is not a case of albinism, for the eyes appear to be as fully pigmented as in the typical form, but there is an almost total suppression of the normal body coloration. The ground color is almost white, but it is tinged with pale bluish on the upper part of the thorax and abdomen and on the legs. There is no indication anywhere of the dark green or blackish pigment, and the only red to be observed is a faint tinge of this color in the region where the abdominal spots occur in the normal form. No structural differences have been observed.

Cases of partial albinism or suppressed development of color have been noted occasionally in various species of animals. Of the crayfish Dr. Ortmann writes thus in reply to a recent letter: "The pale blue color-variety is very remarkable indeed. Bluish specimens, as a color-variety, have been described in European species of *Potamobius* (*Astacus*), but have always been regarded as extraordinary cases. I have occasionally observed slate-blue specimens in *Cambarus bartoni*, but always single individuals only. I have received specimens of a whitish

[5] Paulmier. Higher Crustacea of New York State. Bull. 91, New York State Museum, 1905.

[6] Revision of the *Astacidæ*, Memoirs of the Museum of Harvard College, vol. X, p. 88.



Crayfish. Dorsal Side.

In swimming the crayfish uses his abdomen after the same manner as a lobster. This view shows it turned under, as at the end of a stroke.

Photographs by R. C. Osburn.

Crayfish Covered with Protozoa.

One half natural size specimens from our park lakes are often covered with a profuse growth of a large colonial protozoan attached to their shell.

Female Crayfish.

Under side showing abdominal legs or swimmerets. The last two pairs of walking legs end in spikes, the others have pincers for holding the food.

variety of *C. virilis* from Sandy Lake, Peterboro County, Ontario, Canada, a lake remarkable for its limestone deposits, but here they are all said to be of this color."

More than two dozen specimens of this pale phase of *C. limosus*, of both sexes, have been taken at different times in Prospect Park Lake, Brooklyn, during the past two summers, among about two hundred of the ordinary color phase—no exact counts were made.

What may be the cause of the suppression of the ordinary colors in this and similar cases of partial albinism is not known. Whether it is due to some congenital variation (mutation or saltation), which would then be hereditary, or whether it is due to some physiological condition developed during the life of the individual is unknown, and could only be determined by breeding experiments. From the number of specimens and from the fact that they were taken living with the ordinary variety, it seems probable that the difference is congenital and due to the suppression of a color-developing factor. This assumption is further borne out by the fact that color is not entirely absent, but merely suppressed in large part.

The reproduction of the crayfish is very interesting and has been the subject of much study in this country, especially by Prof. E. A. Andrews,[7] of Johns Hopkins University.

It has long been known that the crayfishes have no larval surface-swimming stages as do their marine relatives, the lobsters and prawns. As early as 1755 von Rosenhof noticed that the young of the European crayfish are similar to the mother and that they remain with her for a time after hatching. Rathke in 1829 showed that the young emerges from the egg in essentially the adult form and so has no metamorphosis. Later, however, Huxley (1879) proved that the young before the first moult are not exactly similar to the adult, but differ in the lack of setae, or bristles, and in the form of the first and sixth abdominal appendages. Thus it will be seen that there is only a slight degree of metamorphosis and of a different sort from that seen in the marine crustacea.

The reason for the elimination of the free-swimming stages is probably to be found in their adaptation to a special habitat. If a surface-swimming stage were present, as in the lobster, the young of the mountain stream species might be carried into the larger streams, while those of the inhabitants of the lowland streams might even be carried out to sea at this period.

The eggs of the crayfishes are regularly laid in the early spring and the time of laying for any species may extend over a considerable period—in *Cambarus bartoni*, for example, from March 15th to May 15th. Chidester[8] has observed that in *C. bartoni* var. *bartoni* there is also an autumnal spawning season beginning with the latter part of September and extending through October and November. Although Chidester does not discuss the matter, this probably does not mean that two broods are produced in a season, but that some of the females mature their eggs in the spring and others in the fall.

Andrews[9] has carefully studied the reproduction of *Cambarus affinis*. Three hundred to six hundred eggs, of a diameter of about one and one half millimeters, are produced. These, as in the lobster, become attached to the under side of the abdomen, especially on the swimmerets, by adhesive portions of the egg envelopes. The eggs are laid in April and May and hatch in a few weeks, the time apparently depending on temperature of water.

When first hatched each young crayfish is attached by the telson thread, a string of cuticle fastened at one end to the telson or last abdominal segment and at the other to the now empty egg membrane. In this condition they remain for two days, when they moult and pass from the first stage to the second. In the second stage also the young are inactive and remain with the mother, but the telson thread is lost and they remain attached by grasping the old egg cases and the abdominal setae with their pincers. During this time they eat nothing and the yolk sac is gradually absorbed. After six days in this condition the skin is again moulted and the young emerge in the third stage. By this time they have taken on the form of the adult, except that the proportions are somewhat different.

The third stage marks the beginning of active life, and while the young remain with the parent more or less closely for a week or so they gradually wander away and begin an independent existence. By fall the young ordinarily reach a length of about two nches and are sexually mature, and the first pairing takes place in October or November of the first year.

After this there are no more moults and consequently no growth until the young have been produced in the following spring.

How long crayfishes live has been ascertained for only a few species. Andrews found no specimens of *Cambarus limosus* living after the third summer, and Ortmann states that, except in occasional individuals, three years constitutes the life period of *C. obscurus*. The European crayfish *Astacus fluviatilis*, has been known to live six years.

Size is dependent largely upon the species. Some of our smaller species do not attain a greater length than a couple of inches. *C. limosus* reaches a maximum of about four inches, while the European *Astacus fluviatilis* grows to nearly eight inches. The largest species known is *Astacopsis franklinii*, found in small treams of Tasmania, which reaches a weight of eight or nine pounds and is thus about equal in size to the European lobster.

The crayfish has many natural enemies. Perhaps the most destructive are various species of fishes, the larger salamanders, such as the mud-puppy (*Necturus*) and hellbender (*Cryptobranchus*) and water-snakes. No doubt the semi-aquatic mammals take their toll and the raccoon is said to be particularly fond of them. Many aquatic birds feed upon them. They are parasitized by leeches, copepod crustaceans and worms. The shells are often overgrown with diatoms and algae, and those from our park lakes are often covered with a profuse growth of a large colonial protozoan (*Epistylus*). It is doubtful if these do any particular harm, except, perhaps, to impede the progress of the crayfish when the growth is abundant. Furthermore, all crayfishes are given to cannibalism to some extent, and not only are young devoured by the adults, but full-grown specimens, when shedding, may be attacked and devoured before the new shell has had time to harden enough to serve for a protection.

[7] The Youth of the Crayfish, *Astacus* and *Cambarus*. Smithsonian Contributions to Knowledge, vol. XXX, pp. 1-79, plates I-X.

[8] *American Naturalist*, May, 1912.

[9] Smithsonian Contributions to Knowledge, vol. XXXV, 1907.

The World's Naval and Merchant Shipbuilding

Extracts from Lloyd's Official Report for 1912

Lloyd's Register has recently published its report of shipbuilding at home and abroad during the past year, and as the Register, with its many surveyors in all countries, has special facilities for gaining accurate information regarding the work, and particularly regarding the tonnage of ships, the figures are more accurate than those compiled by unofficial statisticians. It should be noted, by the way, that Lloyd's do not reckon vessels under 100 tons. The following data, culled from the official announcement, are reproduced here from *Engineering*. Lloyd's Register records a decrease of 104,379 tons in the total output for 1912, of which 65,330 tons is due to merchant vessels, and 39,049 tons to warships.

Special reference is made to some of the important vessels now in progress. There is the Cunard liner "Aquitania," the tonnage of which is given as 45,000 tons. Two other ocean liners of 16,000 tons, and four steamers, of a total tonnage of 4,150 tons, are also to be fitted with steam-turbines. There are nine steamers, with a total gross tonnage of 194,380 tons, to be fitted with a combination of steam-turbines and reciprocating engines. One of these is the "Britannic," of 50,000 tons, for the White Star Line; another, of 32,500 tons, for the Holland-Amerika Line; one, of 27,000 tons, for the Red Star Line; two Royal Mail liners, of 29,900 tons; two vessels, of 31,200 tons, for the Pacific Steam Navigation Company; one of 14,980 tons; and another of 8,800 tons. As regards the marine oil-engine, note is made of the fact that two vessels, of between 3,000 and 4,000 tons each, along with a number of small craft, are being fitted with internal-combustion engines. With forty steamers, of a total tonnage of about 231,000 tons, now being built to carry oil in bulk, this number of motor-ships seems small; because if marine engineers and ship-owners are satisfied with the reliability of the oil-engine, oil-carrying ships present a most favorable opportunity for the application of the system, as commercial conditions are favorable. No better scope for the application of the system could be found. But British firms are obviously indisposed, with the present great demand for tonnage, to risk experiments on such a scale.

The return includes figures to show the surplus of new production over wastage. The gross tonnage of the United Kingdom vessels which have been lost, broken up, etc., during the past twelve months is recorded in this return as 308,000 tons, of which 22,000 tons were sail. British ship-owners have sold to foreign and colonial lines the record total of 704,113 tons of shipping, of which 54,745 tons were sail. Against this large removal from the British register of 1,012,113 tons there has to be placed the small tonnage of vessels built abroad and bought from foreign and colonial owners for inclusions in our fleet afloat. When allowance is made for this it is found that the steam tonnage of the United Kingdom, as the result of the year's operations in building and in sale and purchase, has been increased to the extent of 420,000 tons, while the sailing tonnage has been decreased by about 65,000 tons. The net increase in the British fleet afloat is thus 355,000 tons, but the steady advance in the proportion of steam tonnage, and consequently in the volume of work done in a given time, is, of course, considerably greater. The 355,000 tons is a larger increase than in the preceding four years. The Board of Trade returns show figures for previous years, including all vessels, even those of less than 100 tons; in 1911 the net addition to our fleet was 339,564 tons; in 1910 it was only 66,694 tons, owing to the small amount of work done in the shipyards. In 1909 it was only 150,686 tons, this year marking the lowest point in shipbuilding output for this century. In 1908, again, production was very low, and the addition to the fleet was 161,873 tons. These lean years followed on the fat year of 1907, when the additions to the British fleet afloat made up the large total of 630,706 tons. The addition of new tonnage still goes merrily on, the work on hand for the merchant fleet in British yards being greater than at any previous time in history. A time of reckoning must, however, inevitably come in the recurrence of depression after great activity, but we do not propose to point the moral of these facts as they affect the working classes.

Lloyd's Register is practically the only source whence come completely accurate and comprehensive returns of the work done in foreign as well as in British shipyards. The fact that the figures for each country are on the same basis affords a means of determning the relative progress of the British as compared iwith foreign ship builders. In Table I. there is given the tonnage of merchant ships exceeding 100 tons launched in all countries for a series of years. The total output of the world for last year is 1,719 merchant vessels, of 2,901,769 tons, of which 712 vessels were launched in the United Kingdom, representing 1,738,514 tons—practically 60 per cent of the total. Germany takes second place with only 165 vessels, representing 375,317 tons, so that their quota is only 13 per cent. The United States include 90,000 tons for ships built on the Lakes, making a total of 174 ves-

TABLE I.—Table Showing the Tonnage of Vessels of 100 Tons Gross and Upwards (excluding Warships) Launched in the United Kingdom and Abroad during the Years 1896-1912.

Year.	United Kingdom.	Austria-Hungary.	British Colonies.	Denmark.	France.	Germany.	Holland	Italy.	Japan	Norway	United States.	Other Countries.	Totals.	
	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	No.	tons
1896	1,159,751	6,246	11,124	11,814	44,565	103,295	12,405	6,779	7,849	12,069	184,175	7,830	1113	1,567,882
1897	952,486	6,001	12,431	13,589	40,341	139,728	20,351	12,910	6,740	17,248	86,838	13,711	990	1,331,924
1898	1,367,570	5,432	25,021	12,703	67,160	153,147	19,468	26,530	11,424	22,670	173,250	3,983	1290	1,893,343
1899	1,416,791	9,248	8,464	23,613	89,794	211,684	34,384	49,472	6,775	27,853	224,278	16,382	1299	2,121,738
1900	1,442,471	14,689	9,563	11,060	116,858	204,731	45,074	67,522	4,543	32,751	333,527	21,174	1364	2,304,163
1901	1,524,739	20,013	28,134	22,856	177,543	217,593	29,927	60,526	37,208	36,075	433,235	28,860	1536	2,617,539
1902	1,427,558	15,192	28,819	27,148	192,196	213,961	69,101	46,270	27,181	37,878	379,174	35,277	1650	2,502,755
1903	1,190,618	11,328	34,690	20,609	92,768	184,494	58,174	50,089	34,514	41,500	281,830	35,929	1650	2,145,631
1904	1,205,162	16,645	30,965	15,860	81,245	202,197	56,836	30,016	32,989	50,469	238,518	28,254	1643	1,987,885
1905	1,623,168	16,402	10,798	17,557	73,124	255,423	44,135	61,629	31,725	52,580	302,827	25,554	1576	2,514,922
1906	1,828,343	18,590	26,042	24,712	35,214	318,230	66,809	30,860	42,460	60,774	441,067	28,913	1836	2,919,763
1907	1,607,890	8,717	46,443	28,819	61,685	275,008	65,023	44,686	66,254	57,866	474,675	27,807	1788	2,778,088
1908	929,669	23,502	34,181	19,172	83,429	207,777	58,604	28,864	59,725	52,839	304,543	32,961	1405	1,833,286
1909	991,066	25,006	7,461	7,008	48,197	128,698	50,106	31,217	52,319	28,601	209,604	19,276	1362	1,602,057
1910	1,143,169	14,304	26,343	12,154	90,761	159,303	70,945	23,019	30,215	36,981	331,318	29,461	1677	1,957,853
1911	1,803,844	37,836	19,662	18,669	125,472	255,532	98,080	17,401	44,389	35,415	171,669	27,291	1880	2,650,140
1912	1,738,514	34,790	36,821	28,105	110,734	375,317	98,439	25,106	57,756	50,256	284,223	60,672	1719	2,901,769

TABLE II.—Table Showing the Number and Displacement of Warships of 100 Tons and Upwards Launched for the Various Navies during the Years 1896 to 1912.

Year.	British.	American (United States).	Austro-Hungarian.	French.	German.	Italian.	Japanese.	Russian.	Other Flags.	Total.	
	tons	tons	tons	tons	tons	tons	tons	tons	tons	No.	tons
1896	117,445	16,302	6,080	57,110	11,100	6,500	24,780	30,281	62,213	92	331,781
1897	66,740	3,000	2,250	15,155	44,214	26,906	18,070	2,300	41,325	90	228,900
1898	140,130	87,900	6,350	25,096	10,648	2,836	45,275	38,650	49,908	91	396,673
1899	131,140	6,400	2,540	52,912	39,240	18,130	61,636	27,330	15,402	91	344,780
1900	35,050	12,380	10,600	40,730	45,380	1,290	26,210	61,840	27,094	99	260,464
1901	209,774	47,908	7,400	40,063	59,400	27,553	1,125	54,600	18,769	123	467,547
1902	92,840	30,449	8,169	44,120	32,324	8,724	3,350	43,485	14,025	102	278,108
1903	147,813	66,140	17,880	30,700	60,680	..	18,917	33,420	15,930	119	391,180
1904	128,375	170,185	11,480	43,600	44,970	25,922	608	1,730	10,108	102	435,006
1905	96,505	98,200	11,060	28,611	36,487	14,460	50,033	15,721	11,544	118	363,231
1906	85,700	45,443	2,760	15,188	62,678	3,030	41,277	82,304	24,080	148	362,978
1907	133,405	11,590	1,894	33,594	14,800	25,154	57,300	35,317	8,557	142	321,311
1908	49,560	52,880	16,153	21,600	97,680	29,400	2,245	8,800	31,421	127	309,089
1909	96,790	48,680	22,217	96,740	90,116	2,066	373	1,246	55,294	151	404,675
1910	138,825	30,287	14,960	24,063	48,034	19,374	23,100	..	16,480	122	310,884
1911	221,430	57,526	20,290	52,985	128,360	75,013	37,071	93,380	82,980	169	763,865
1912	168,087	62,673	49,961	55,965	90,410	14,080	56,035	498	23,267	174	534,[illegible]

sels, of 284,223 tons, launched during the past year. This proportion is 9.8 per cent. France takes fourth place with 80 vessels, of 110,734 tons, a proportion of 3.8 per cent; and Holland, with 112 vessels, of 99,439 tons, contributes 3.43 per cent of the total; Japan, which comes next, launched 168 vessels, of 57,755 tons. Thus it will be seen that Great Britain holds a strong position. In 1911, however, the British proportion was 68 per cent; in 1907, the last year of great activity, the ratio was 58 per cent, and in 1906, 63 per cent; but in years of depression the British percentage has only been 50 per cent.

Table III.—*Number and Tonnage of Warships Launched in the United Kingdom and Abroad Respectively.*

Year.	United Kingdom.		Abroad.	
	No.	Tons.	No.	Tons.
1896	55	163,958	37	167,833
1897	48	95,465	42	133,435
1898	41	191,555	50	175,318
1899	35	168,590	56	176,170
1900	29	68,364	70	192,100
1901	41	211,969	82	255,578
1902	23	94,140	79	183,966
1903	41	151,890	78	239,210
1904	37	127,175	65	307,831
1905	28	129,801	90	233,410
1906	29	108,450	119	254,522
1907	36	134,475	106	186,736
1908	36	74,186	91	235,503
1909	42	126,230	109	278,245
1910	45	134,645	77	176,209
1911	50	230,786	119	538,063
1912	30	191,737	141	342,892

Thus the proportion of the past year is well up to the average. We have already indicated that Germany's proportion for 1912 was 13 per cent; in 1911 it was 9.7 per cent; and in 1906, when also there was great activity, it was 11 per cent; in 1904-8 it was over 10 per cent. In 1912 Germany considerably improved its relative position. In the case of the United States the proportion is considerably more than in 1911, when, however, the total was abnormally low—namely, 6½ per cent. In 1910, on the other hand, it was 17 per cent. The French total is less than in the previous years, their 3.8 per cent for 1912 comparing with 4.75 and 4.13 per cent in the two previous years. Holland's proportion is practically the same as in the previous year, when it was 3½ per cent, and 3.63 per cent in 1910. Generally, the other countries have not made headway when consideration is had to the large increase in the world's output. The total increase in the world's production of merchant ships is 251,629 tons; but 1912 does not constitute a record, 1906 still holding an advantage of 17,994 tons.

Table II. shows the displacement tonnage of warships exceeding 100 tons, launched for the various navies. It should be noted that the vessels have not necessarily been launched in the country in which they are owned. The abnormal output of 1911 was not maintained during 1912, but the total is still only second to the figures then recorded. The decrease, it will be seen, is 234,240 tons. This is attributable largely to Britain and Germany. The decrease would be regarded with some degree of satisfaction were the figures indicative of any lessening of the competition in armaments, but the present state of affairs does not justify any such view. It will be noted that the total output is 174 vessels, of 534,629 tons. The aggregate for the two past years is therefore over 1,300,000 tons, equal to an average of 650,000 tons. This is nearly 40 per cent higher than the largest total for any previous year. The British proportion of the total of the two past years is 30 per cent, which, against the proportion of 60 per cent of the world's merchant tonnage launched, constitutes matter for reflection. The German total is 18¼ per cent, which compares with her proportion of 13 per cent of the world's merchant shipping output.

America, it will be seen, has added 5,000 tons to the displacement of their warships launched as compared with the previous year; France, 2,000 tons; Japan, 19,000 tons; and Austria-Hungary, 29,000 tons. The British total is 58,343 tons less; the Italian total, 60,079 tons less; and the Russian total, 92,768 tons less. No significance need be attached to such increases or decreases, because the figures from year to year must fluctuate. In the case of Russia, for instance, there is greater activity in the building of warships at the present time than in 1911, and in other States the tendency is distinctly toward increased production in warships.

We have said that the figures given in Table II. must not be regarded as the warship output in the respective countries. In Table III. we give a list showing the number and tonnage of warships launched in the United Kingdom as compared with the output of all other countries, irrespective of the navies for which they were intended. In 1912 we launched fewer warships than in the previous year, although with this exception, the total is the largest recorded since 1901, the year when very large additions were made to the British Fleet. As we have already pointed out, there are great fluctuations in the production of warships in one year as compared with others, but it will be seen that the ratio of British to foreign warship output was last year 1 : 1.80; in 1911 it was 1 : 2.32; and in 1910 it was 1 : 1.31. It may be taken that, so far as this proportion is concerned, last year was an average.

In Table IV. there is given the total production in each maritime country, including merchant and war ships over 100 tons. In nearly all cases there is recorded considerable increase as compared with the previous year, and in many instances record totals have been achieved. In the case of Germany the total is 200 vessels, of 477,742 tons. This includes the largest vessel built during the year, the "Imperator," of about 52,000 tons, launched by the Vulcan Company at Hamburg, and soon to take her place in the Hamburg-American express line to New York. The merchant shipping output shows an increase of nearly 120,000 tons, and the total increase, reckoning all ships, is 90,265 tons, the difference, of course, being due to the less number of warships built. The total, nevertheless, is a record. The figures, however, do not take into account the large number of river craft launched at yards situated in inland waters. Five of the vessels built, representing 18,258 tons, were fitted with internal-combustion engines, the largest being an oil-carrying steamer of 5,810 tons. There were ten other vessels, averaging 271 tons, fitted with oil-engines. There are under construction a turbine-steamer of about 58,000 tons, also at the Vulcan Works at Hamburg, a steamer of about 35,000 tons, three between 20,000 and 25,000 tons (one of them to be fitted with turbines), two between 10,000 and 15,000 tons, and thirty other vessels of between 5,000 tons and 10,000 tons, including eleven to carry oil in bulk, three of which will be fitted with Diesel engines.

Table IV.—*Showing Tonnage of Merchant and War Vessels (over 100 Tons) Launched.*

—	1909.	1910.	1911.	1912.
Austria-Hungary ..	47,223	29,297	58,105	88,742
Belgium	6,316	6,226	7,563	18,542
British Colonies ..	7,941	26,343	19,662	34,790
China	—	3,942	2,189	8,681
Denmark	7,508	12,371	19,651	26,263
France	137,937	105,114	184,184	169,889
Germany	228,009	210,367	387,477	477,742
Holland	65,522	71,761	93,670	101,642
Italy	33,405	52,073	92,719	40,060
Japan	52,604	53,315	81,790	88,731
Norway	28,601	37,481	35,535	50,358
Russia	4,331	4,395	96,264	15,663
Spain	2,174	3,234	6,598	21,580
Sweden	7,487	9,869	9,852	13,968
United States	258,243	361,605	287,550	349,496
Other countries ..	—	150	120	—
Total foreign and colonial	889,236	990,893	1,384,379	1,506,147
Total for the United Kingdom	1,117,296	1,277,814	2,034,630	1,930,251
Total for world ..	2,006,532	2,268,707	3,419,009	3,436,398

The United States total output, including all vessels, as given in Table IV., is 190 vessels, of 349,496 tons. This is not the highest reached, as the total was exceeded, among other years, in 1908 and 1910, but it is 61,946 tons greater than in 1911. Taking merchant ships only, as in Table I., the increase is 112,000 tons, due to more work being done in the shipyards on the coast. The tonnage launched on the Great Lakes amounts to nearly 90,000 tons, and includes six vessels of over 5,000 tons, the largest being about 8,600 tons. On the coast only four sea-going merchant ships were launched; these were of between 5,000 and 7,000 tons, in addition to four colliers, of about 10,000 tons, for the United States Navy. Of these vessels, one is being fitted with electrical transmission between the turbines and propellers, while another has mechanical gear. There are in course of construction 11 steamers of between 5,000 and 9,000 tons.

The 108 vessels, of 169,889 tons, constitute a larger output for France than for several years, except 1911, when the total was 14,295 tons greater than for the past twelve months, as shown in Table IV. Regarding the purely merchant work, however (Table I.), it is seen that there is a decrease of nearly 15,000 tons. The output included six vessels of over 5,000 tons; the largest was the "Mississippi," of about 7,000 tons, and a turbine Channel steamer "Rouen," of 1,656 tons, was designed for a speed of 22 knots. The merchant work on hand (175,000 tons) considerably exceeds the output of 1912, and four of the vessels are between 12,000 tons and 15,000 tons. Two of these will be fitted with combination turbines and reciprocating machinery.

In Holland the total output of all shipping was greater than in previous years, the 117 vessels launched making up 101,642 tons. As regards the merchant work, the total is 6,400 tons above the output of 1911, and is the largest ever recorded in such return. As in the case of Germany, there is not included the vessels for river navigation, of which more than 90,000 tons were launched in 1912. The larger vessels launched were three, of between 6,000 and 7,000 tons. Here, again, the internal-combustion engine is making headway, two large vessels and 17 small vessels having been fitted with such machinery, while on hand there are two cargo steamers, each of 4,500 tons, to be propelled by Diesel engines. In the case of Japan, the total of merchant and war tonnage produced included 174 vessels of 88,731 tons, which is about 7,000 tons more than in the previous year. The merchant tonnage consisted almost entirely of small vessels, with the exception of two steamers of about 6,500 tons. The increase in the merchant total, it will be seen, is about 13,400 tons. In the output of Austria-Hungary there is an increase of 30,637 tons. Part of this, however, is due to activity in warship-building works, the increase in merchant work being only 3,000 tons. The output was made up almost entirely of vessels between 5,000 and 8,000 tons. In progress there are new ships of 57,000 tons. The Norwegian total, composed entirely of merchant vessels, with the exception of one warship of 103 tons, represents 50,358 tons, the measurement of 90 vessels, nearly all small craft. This is nearly 15,000 tons more than in the previous year.

The output of the British Colonies, of course, does not include any warships, and is 15,000 tons more than in 1911. Only a small proportion of the increase is due to sea-going tonnage. Denmark shows an increase of less than 7,000 tons, and there is included in the output two vessels of 4,934 tons and 3,716 tons, fitted with Diesel engines. This method of propulsion is recorded by Lloyd's Register as being adopted by several cargo vessels of considerable size building in Copenhagen.

Extinct Monsters of Alberta

The Director of the Geological Survey reports that great success attended the expedition sent out last summer to secure skeletons of the great extinct monsters that once inhabited the Canadian Northwest and whose remains are now found in vast quantities in bone beds of the Red Deer River, Alberta.

This well equipped expedition has returned with tons of fossil remains, principally those of dinosaurs, huge reptiles that flourished four or five million years ago toward the close of what the geologists call the Cretaceous period. Included in the collections are: two skeletons of the large plant-eating Trachodon or Duck-billed dinosaur, one 32 feet long, and the other 40 feet long; remains of the ponderous plant-eating horned dinosaurs; and of the flesh-eating dinosaur, now being called Albertosaurus. Credit for this fine collection belongs to Mr. Charles Sternberg, who was in charge of the season's operations. Mr. Sternberg was collector for the late Prof. Cope and has the reputation of being perhaps the best and most successful fossil-hunter. Disengaging the bones from the rock, preserving, preparing, and mounting them is a delicate operation requiring great skill and patience. The big dinosaurs are now being prepared for exhibition, in the palæontological workshop at the Museum. The 32-foot reptile is being made into a panel mount which will show the position in which the creature was buried. The big 40-foot specimen will be erected as an open mount, which will display to advantage his huge dimensions and give a clear idea of his imposing presence when he was a reigning monarch of the wilderness. The material collected last summer, together with many specimens collected in earlier expeditions will pass through the hands of the skilled preparators, to increase the size and attractiveness of the palæontological collection recently opened to the public in the Victoria Memorial Museum.

It may be noted that this now famous fossil locality of Alberta was discovered by the Canadian Geological Survey in 1884, when J. B. Tyrrell, exploring on the plains, uncovered the head of the Albertosaurus, which has been on exhibition in the Survey for the past quarter of a century. In 1889, T. Weston, a former collector of the Survey, was sent out to secure more material. In 1892, the Survey published a monograph by Prof. Cope on the material collected. In 1897, 1898, and 1901, L. M. Lambe, Vertebrate Palæontologist of the Survey, was at work in this field bringing to light many new forms of the past life of our western country, including fishes, reptiles, turtles, dinosaurs, and small primitive mammals which have been figured and described in memoirs and papers of the Survey published in 1902, 1906, and at intervals since.

The expedition of the past season, however, was stronger and better equipped than any heretofore sent out by the Survey and the gratifying success which it has achieved will, it is hoped, be followed up by further vigorous collecting during the coming summer.

Preventing the Steaming of Windows

An ingenious device for preventing the steaming of windows in cold weather is described in the *Electrical Review and Western Electrician*. The apparatus consists simply of a fish tail burner, through the flame of which a blast of air is directed against the window. The air is dried in passing through the flame and, in spreading over the surface of the window, completely prevents any deposit of moisture thereon. The fan is actuated by a small electric motor. In a trial of the apparatus a window was completely covered with steam from a kettle. On application of blast from the apparatus, the window was cleared in 30 seconds, and no new deposit was produced so long as the apparatus was at work.

NEW BOOKS, ETC.

Annual Tables of Constants and Numerical Data, Chemical, Physical and Technological. Published under the auspices of the International Association of Academies, and under the direction of an international commission appointed by the VII International Congress of Applied Chemistry. Volume I, for the year 1910. Size 9 × 11 inches. xxxix + 727 pp. Chicago: University of Chicago Press. 1912. Price, $6.

A good table of constants is among the most useful reference volumes on the shelf of every scientific worker—and it is not surprising to find that tables of this character have of late years been appearing in considerable variety. In most cases they were the result of private initiative, though we have in the Smithsonian Tables a work produced under the auspices of a public institution. But one serious drawback of most works of this character is that, with the rapid progress of science, in but a few years many of the data found in such a table are out of date, while others, which have become available in the periodical literature, are looked for in vain in the table. The annual publication of an excellent volume of tables of the constants determined during each year must therefore be hailed with welcome, especially when it bears every sign of having been prepared with great thoroughness and care under the auspices of so representative and distinguished a body as the International Association of Academies. The volume before us bears the date of publication 1912 and contains the values of all physical quantities published during 1910 in all parts of the world, together with the name of the investigator, place of publication and experimental method employed. It will no longer be necessary for the individual investigator to search the literature for the latest value of any constant; for the searching process has been carried out by the large corps of abstractors of these tables, much more thoroughly than the individual could ever hope to do it.

The text of the tables is in French, but a table of contents with directions for employing the tables is given in English, German, French, and Italian. Something of the magnitude of the work which this table represents may be gathered from the fact that in its preparation no less than three hundred periodicals and scientific publications have been searched by thirty-one eminent collaborators. The editor is Dr. Charles Marie, to whose initiative the work owes its origin. The compilers have given their services free, and all interested should show their appreciation by giving the movement their active support.

Industrial and Manufacturing Chemistry. Organic. By Geoffrey Martin. Assisted by a staff of fourteen specialists. New York: D. Appleton & Co., 1913. 6x10 inches, 726 pp. With numerous illustrations Price, $6.

The great importance of chemistry to the industry of the present day has brought upon the market a number of more or less valuable books dealing with chemistry, especially in its application to the useful arts. The book which we have before us for review is a new addition to this class, and we may say, a very welcome addition. The book may be said to occupy an intermediate position between the large cyclopedic works written by a large staff of contributors, and very excellent in their way, but often too cumbrous, and also, we regret to say, often very slow in their publication; and on the other hand, the smaller works, written as a rule by one man, which are open to the obvious objection that no one individual is likely to command thoroughly the whole field of applied chemistry. A perusal of the book seems to show that both the editor and his assistants have done their tasks well. The scope of the book is best shown by a brief extract from the chapter headings. The book is divided into twenty-three sections, of which the first is devoted to the oil, fat, varnish, and soap industry, the second to the sugar industry, the third to the starch industry, and the fourth to the cellulose industry, including wood pulp manufacture, paper making, celluloid, and artificial silk processes. Section V deals with the fermentation industries, section VI with the charcoal and wood-distilling industries, section VII treats of the turpentine and rosin industry, while industrial gums and resins are placed in a separate section VIII. An important chapter is section IX, on the rubber industry, the second part of which is devoted to synthetic rubber. Section X is headed "The Industry of Aliphatic Chemicals" and deals with such compounds as oxalic acid, formic acid, tartaric acid, aldehyde, alcohol, ethers and esters. Sections XI, XII and XIII are closely related, dealing respectively with the illuminating gas industry, the industry of coal tar and coal tar products, and the industry of synthetic coloring matters. The natural dyestuffs are considered separately in section XIV. Section XV takes up the ink industry, while paint and pigments are considered in section XVI. The remaining sections are in order as follows: XVII, textile fiber, bleaching and waterproofing industries; XVIII, the dyeing and color printing industry; XIX, the leather and tanning industry; XX, glue, gelatine and albumen industry; XXI, the industry of modern synthetic and other drugs; XXII, the modern explosives industry; XXIII, the industry of photographic chemicals.

The publishers have performed their part well. The paper is substantial, the print is large and clear, abundant use having been made of bold-face keywords and headings. There is no stinting of space. Many illustrations in the text assist the reader to obtain a proper comprehension of the subjects. The book is carefully indexed. It should prove a valuable work of reference on every chemist's bookshelf.

Lectures Delivered at the Celebration of the Twentieth Anniversary of the Foundation of Clark University. Under the Auspices of the Department of Physics. By Vito Volterra, Ernest Rutherford, Robert Williams Wood, Carl Barrus. Published by the Clark University, 1912.

The little volume before us is a collection of most excellent lectures on selected topics delivered at Clark University by some of the world's greatest authorities.

Prof. Vito Volterra of the University of Rome contributes a chapter on "Some Recent Advances in Mathematical Physics." Prof. Volterra is famous for his pioneer researches in the theory and application of integral equations. Those readers who are interested in the most modern methods of dealing with physical problems by the aid of mathematical methods can hardly afford to let this paper pass unread.

Prof. Volterra's contribution comprises three lectures. The first of these opens with some introductory remarks on mathematical analysis as applied to physics. The author then goes on to consider the Maxwellian theory of the electrostatic field, and shows how the equation of electrodynamics can be deduced by the aid of the calculus of variations, and how this method of deduction presents certain points of special interest. In the course of developments Minkowski's four-dimensional representation of events in a physical system is considered in its relation to the principle of relativity. The second lecture takes up problems in the theory of elasticity. Here Prof. Volterra introduces integral equations, the use of which is further developed in the third lecture, dealing with residual effects, elastic hysteresis and, generally, systems displaying the properties of heredity, to use Prof. Volterra's expression—that is to say, systems whose condition at any instant is a function of their entire past history.

The second contribution is a lecture by Prof. E. Rutherford on the "History of the Alpha Rays from Radioactive Substances." Our readers will remember how Prof. Ramsay in conjunction with Mr. Frederick Soddy demonstrated that the alpha particle is nothing but a helium atom carrying an electric charge. The further development of our knowledge relating to alpha rays reads more like a romance than like a staid chapter from the scientific laboratory. In his review Prof. Rutherford tells us how these alpha particles or helium atoms have been counted by taking advantage of their phenomenal velocity—a matter of some twelve thousand miles per second—by virtue of which each individual atom becomes visible as a flash of light when it impinges upon a phosphorescent screen of zinc blende. We know of no better summary of our knowledge relating to alpha rays and their relation to the constitution of matter than Prof. Rutherford's lecture at the Clark University.

The third contribution is from Prof. R. W. Wood of the Johns Hopkins University, and deals with the optical properties of metallic vapors. Prof. Wood has found that under certain circumstances metallic vapors are capable of reflecting light in much the same way as a silvered mirror, except that such vapors affect only certain particular wave-lengths. This and other matters are taken up in detail by Prof. Wood in his lecture.

Prof. Barrus lectured on "Certain Physical properties of the Iron Carbides, together with Inferences Deducible Therefrom."

All those who know how to appreciate the value of such scientific research, as this for its bearing upon a variety of practical applications in the arts, whether it be in the use of structural iron in building, or the employment of special steels and alloys of iron for electrical and magnetic purposes, will welcome this paper as a most valuable contribution to our knowledge of the subject.

Industrial Organic Chemistry. Adapted for the Use of Manufacturers, Chemists, and all Interested in the Utilization of Organic Materials in the Industrial Arts. By Samuel P. Sadtler, Ph.D., LL.D. Fourth Edition, revised, enlarged, and reset. Philadelphia, 1912. Large Octavo.

Prof. Sadtler's book has deservedly taken high rank among general American works on industrial chemistry. Since its appearance in 1891, the book has been revised over and over again and brought up to date. In this last edition we find the general plan, an excellent one, still adhered to. In surveying the several industries, the raw materials are first enumerated and described; then the processes of manufacture are given in outline, and explained; next the products, both intermediate and final, are characterized and their composition illustrated in many cases by tables of analyses; then the most important analytical tests and methods are given, that seem to be of value either in the control of the processes of manufacture or in determining the purity of the product; and lastly, the bibliography and statistics of each industry are given, so that an idea of the present development and relative importance of the industry may be had. The fourteen chapters of the book are devoted to the petroleum and mineral oil industry, the industry of fats and fatty oils, the industry of the essential oils and resins, the cane sugar industry, the industries of starch products, fermentation industries, milk industries, vegetable textile fibers, textile fibers of animal origin, animal tissues and their products, industries based upon destructive distillation, the artificial coloring matters, natural dye colors, bleaching, dyeing, and textile printing. An appendix is provided, devoted to the metric system, a table for determination of temperature, and specific gravity tables, alcohol tables, and physical and chemical contents of mixed oils and fats.

Modern Destructor Practice. By W. Francis Goodrich. Philadelphia: J. B. Lippincott Company, 1912. 8vo.; 278 pp.; 116 illustrations and 46 tables.

"Modern Destructor Practice" deals with the disposal of refuse by incineration in cities and towns. It is a fairly comprehensive review of modern practice. The author gave us a similar work some eight or nine years ago, but destructor development has moved apace in that time, both in Great Britain, from which standpoint the author writes, and on the Continent. The three alternative means of refuse disposal, tipping, or as we should say, dumping, on land, tipping at sea, and the pulverizing and conversion of refuse into manure, are all condemned, the first two as inadequate and unsanitary, the last as inadequate and expensive. Representative types of British destructors are described in detail, with plates and inserts that show very clearly the construction and operation. Destructors in combination with sewage works and with electricity works are impartially considered, and the destructors of Great Britain are listed alphabetically by towns, with information as to maker, type, number of cells, boilers, height of chimney, utilization of power, and date of erection. The utilization of residuals, of heat, clinker, ashes, tins, etc., is an important consideration, and is given separate chapters. Foreign and Colonial, United States and Canadian practice concludes the volume. The author is far from complimentary to the American incinerator, perhaps not without some show of justice, and believes that British types have proved themselves capable of dealing with the severe and complex conditions of American demand.

Farmers' Manual of Law. Principles of Private Substantive Law. A Manual of Law Adapted for the Use of Farmers and Students in Agricultural Colleges. By Hugh Evander Willis. New York: Orange Judd Company, 1911. 8vo.; 458 pp. Price, $2.

To tell the farmer plainly what his legal rights are, and what he may require his neighbor to do and to refrain from doing, this is the aim and substance of Mr. Willis' volume. It covers exhaustively private substantive law. The greater space is given to questions in which a farmer is most likely to become involved, but nearly all cases for which the State provides remedies are set forth, if but briefly. The work is not intended to fit a complainant or defendant to present his own case before the court, but it does aim to inform him clearly as to his legal rights, in so far as private substantive law is concerned. Personal safety, control of family and dependents, title by occupancy, title by contracts, and many other phases of peculiar application to the interests of the farmer, are simply set forth, with citations of cases based on similar circumstances. A variety of forms, warranty deeds, leases, real estate mortgages, etc., are wisely included in the volume, which should prove eminently acceptable to the intelligent farming community.

The Principles of Parallel Projecting-line Drawing. By Alphonse A. Adler, B.S., M.E. Part I of The Theory of Engineering Drawing. New York: D. Van Nostrand Company, 1912. 8vo.; 66 pp.; illustrated. Price, $1 net.

The author is instructor in mechanical drawing and designing in the Polytechnic Institute of Brooklyn. His introduction deals with the nature of drawing, its science and art, and its commercial application. Oblique projection, orthographic projection, and axonometric projection form the three main divisions of the work, in which the subject is intelligibly presented to the student. The author seeks to present fundamental principles rather than methods, holding that "methods frequently make short cuts to quick applications, but they are detrimental to mental development and act as dead weight on the memory."

The Standard Illustrated Book of Facts. A Comprehensive Survey of the World's Knowledge and Progress. With an Historical, Scientific, Statistical, Geographical, and Literary Appendix. Editor-in-Chief, Harry Thurston Peck, Ph.D., LL.D.; Associate Editor, Robert Campbell Auld, F.Z.S. 8vo.; 1,150 pp.; illustrated. New York: Syndicate Publishing Company.

Here is a work of reference that will no doubt receive the seal of popular approval. It contains a marvellous amount of up-to-the-minute information on the most diverse subjects. The mythology of ancient Greece elbows American politics of 1912. Scientific theories, industrial processes, natural and artificial products, religions and philosophies, men and manners, all are ingeniously defined, explained, and described in paragraphs averaging little more than a hundred words. The addenda consist of commercial and legal terms, familiar allusions, famous characters in poetry and prose, the gist of patent and copyright requirements, postal information, automobile and aviation terms, a chronological table of the world's greatest events, and many other features of popular interest. As a book for the family table, it will doubtless be constantly consulted by old and young.

Gold Mine Accounts and Costing. A Practical Manual for Officials, Accountants, Bookkeepers, etc. By G. W. Tait. London: Sir Isaac Pitman & Sons, Ltd. 8vo.; 85 pp. Price, $2 net.

The author kept the accounts of the Rand Mines of South Africa for many years, and is hence highly qualified to speak on the subject of mine accounting. To all who are interested in any way in mining bookkeeping or mining balance sheets, the papers will make clear the approved practice. A few errors have escaped the proofreader, but these are obvious, and do not cause any serious misunderstandings.

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